



Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA

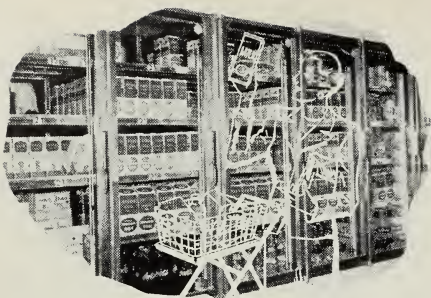
MILK DELIVERY COSTS and VOLUME PRICING PROCEDURES in California

D. A. Clarke, Jr.



CALIFORNIA AGRICULTURAL
EXPERIMENT STATION

BULLETIN 757



The system of uniform pricing in milk distribution, used for many years in California, encourages

- hidden rebates
- the growth of captive creameries
- inefficiencies of distribution, such as the serving of a single customer by several distributors.

By failing to effect real economies through appropriate price reductions, the system has not provided an incentive for consumers to choose more efficient distribution methods.

Furthermore, the system of flat pricing is inadequate and inequitable.

Possible alternatives:

1. A system of service charges coupled with reduced levels of flat prices could reflect actual costs and margins quite accurately.
2. A system of volume discounts, while less accurate, would be superior to the flat price plan.

Results of the research reported here may be applied . . .

1. To provide a basis upon which administered prices could more closely approximate perfect market prices.
2. To suggest the nature of the savings that can be expected with a more "realistic" system of pricing.

GENERAL discussion of fluid milk pricing will be found on pages 3 to 18.

SPECIFIC details of the development of the analysis appear on pages 18 to 66.

THE AUTHOR:

D. A. Clarke, Jr., is Associate Agricultural Economist in the Experiment Station and on the Giannini Foundation, Berkeley.

MILK DELIVERY COSTS and VOLUME PRICING PROCEDURES in CALIFORNIA¹

D. A. CLARKE, JR.

Introduction

FLUID MILK DISTRIBUTION consists of a series of operations performed in getting milk from the farm to the ultimate consumer. The "costs" of these marketing operations are often measured by use of average price spreads, such as those shown in table 1. The term "price spread" (or simply "spread"), as used in this bulletin, refers to the difference in prices at various levels in the marketing system. Most of the available data on prices, however, quote the price paid to farmers f.o.b. city plant. Therefore, the costs of country assembly and transportation to the city are excluded from these particular measures of marketing charges, and the figures refer directly to the charges added for plant processing and bottling, delivery, and store margins where the milk is sold through such outlets. As the table shows, many of the 137 cities have higher prices and wider spreads than do the California markets, while many other cities have lower prices and narrower spreads.

Such comparisons are often used to measure the relative efficiency of different markets. It must be recognized, however, that at best they are poor indices of efficiency in terms of either the output per unit of input or the extent to which prices reflect "necessary" costs as distinct from monopoly returns to producers, labor, or distributors. While it is true

that higher marketing charges in one area than in another *may* mean that the second market is the more efficient, wide spreads may also result from differences in relative incomes of the two areas as reflected by wages for plant and delivery-men. Furthermore, variation in spreads may represent substantial differences in quality, in sanitary controls, and in added services and convenience to the customer. Differences of these types can be enumerated and, to an extent, measured, but it is extremely difficult to devise a measure of their value (or "utility") to consumers. (For a discussion of the difficulties involved in the use of prices and margins as a measure of efficiency, see 1; 13).² If, for example, utility did not differ, then it could be said that the distribution of milk through stores is more "efficient" than the system of retail home deliveries, because the "store differential" (difference between consumer prices at stores and home-delivered) in 137 cities averaged 0.7 cent per quart, and in California markets, 0.6 cent. Yet some customers do choose to pay for home delivery. In fact, in a survey made in Connecticut in 1946, 44 per cent of the consumers interviewed in Willimantic and 63 per cent of those in Hartford indicated they would be unwilling to give up home-delivery services for less than a 5-cent store differential (2), thus indicating a substantial difference in the utility, to them, of the alternative product-service combinations.

¹ Submitted for publication April 3, 1956.

² Italicized numbers in parentheses refer to "Literature Cited," page 76.

**Table 1. Price Spread in Milk Distribution, 137 United States Cities and 37 California Marketing Areas,
January, 1956**

Retail spreads			Wholesale spreads			Store spreads			Wholesale and store			Store differential		
Cents per quart	Number of cities		Cents per quart	Number of cities		Cents per quart	Number of cities		Cents per quart	Number of cities		Cents per quart	Number of cities	
	United States	Cal- ifornia		United States	Cal- ifornia		United States	Cal- ifornia		United States	Cal- ifornia		United States	Cal- ifornia
7.5-7.9	0	0	5.5-5.9	0	0	0.0-0.4	7	0	7.5-7.9	2	0	0.0-0.4	68	14
8.0-8.4	0	0	6.0-6.4	2	0	0.5-0.9	5	0	8.0-8.4	3	0	0.5-0.9	5	4
8.5-8.9	0	0	6.5-6.9	3	1	1.0-1.4	18	0	8.5-8.9	5	0	1.0-1.4	33	19
9.0-9.4	4	1	7.0-7.4	3	7	1.5-1.9	16	1	9.0-9.4	7	6	1.5-1.9	9	0
9.5-9.9	1	2	7.5-7.9	16	17	2.0-2.4	44	19	9.5-9.9	8	8	2.0-2.4	13	0
10.0-10.4	11	8	8.0-8.4	14	7	2.5-2.9	26	17	10.0-10.4	22	13	2.5-2.9	5	
10.5-10.9	16	14	8.5-8.9	26	2	3.0-3.4	15	0	10.5-10.9	14	6	3.0-3.4	1	
11.0-11.4	26	8	9.0-9.4	26	2	3.5-3.9	2	0	11.0-11.4	24	2	3.5-3.9	1	
11.5-11.9	30	3	9.5-9.9	15	0	4.0-4.4	2	0	11.5-11.9	25	1	4.0-4.4	0	
12.0-12.4	15	1	10.0-10.4	14	1	4.5-4.9	2	0	12.0-12.4	8	1	4.5-4.9	0	
12.5-12.9	10	0	10.5-10.9	11	0				12.5-12.9	9	0	5.0-5.4	2	
13.0-13.4	9	0	11.0-11.4	3	0				13.0-13.4	3	0			
13.5-13.9	7	0	11.5-11.9	2	0				13.5-13.9	4	0			
14.0-14.4	2	0	12.0-12.4	1	0				14.0-14.4	2	0			
14.5-14.9	3	0	12.5-12.9	0	0				14.5-14.9	0	0			
15.0-15.4	1	0	13.0-13.4	0	0				15.0-15.4	0	0			
15.5-15.9	1	0	13.5-13.9	1	0				15.5-15.9	0	0			
16.0-16.4	1	0							16.0-16.4	1	0			
Simple average price spreads*														
	11.8	10.8		9.1	7.9		2.0	2.3		11.1	10.2		0.7	0.6

* Averages calculated from original data and may not reconcile exactly due to rounding.
 Sources: United States data from: U. S. Agricultural Marketing Service, "Fluid Milk and Cream Report" (Washington: Govt. Print. Off., January, 1956). California data from: California Crop and Livestock Reporting Service, "Dairy Information Bulletin" (Sacramento, January, 1956), vol. XII, no. 10. (Data for October, 1955.) California raw product cost based on 3.6 per cent butterfat.

The major differences between costs of wholesale and retail milk distribution occur in the items of processing and delivery. Processing costs are higher for wholesale, reflecting primarily the difference in container expense. Practically all milk sold at wholesale in California is in fiber containers; retail sales are made in glass. The difference in expense amounts to about 1.1 cents per quart more for fiber containers than for returnable glass bottles. Lower delivery expense for wholesale, on the other hand, results from the larger volume of output per man on wholesale routes. This in turn is influenced by the lighter and more compact fiber containers, especially where large-volume customers are concerned.

Relative importance of wholesale and retail milk sales. The proportions of total milk sales through wholesale channels—grocery stores, restaurants, and institutions—vary considerably by areas in the United States. Table 2 shows the amount of this variation and the relative importance of sales through outlets of this type as of January, 1950 (the latest date for which nationwide figures are available). With the exception of New York City, sales at wholesale appear to be a more important factor on the West Coast than on the East Coast. West Coast markets typically average 50 per cent or more sales through wholesale channels, whereas very few of the eastern markets report more than 35 per cent of total sales through these outlets.

Structural characteristics of the industry. Fluid milk processing and distributing are subject to economies of large-scale operation. In general, plants with large volumes have lower unit costs than those with small volumes even when both are operating at the same degree of capacity. On the other hand, because of particular advantages, such as special abilities that result in high efficiencies in plant and/or delivery operations, the availability of unpaid family labor, a

desire to be "on their own," or for other reasons, there are a large number of small distributors. Thus, most milk markets contain a small number of large distributors and a large number of relatively small operators.

Typically, the sales of the three largest distributors account for approximately half of the total sales within the local market. For example, in 1954, the three largest handlers in Sacramento made 66

Table 2. Per Cent of Total Milk Sales Classified as Wholesale *

Market	Wholesale as per cent of total sales
Portland, Maine.....	30
Manchester-Nashua, New Hampshire.....	30
Portsmouth, New Hampshire	20
Burlington, Vermont.....	40
Boston, Massachusetts.....	35
Worcester, Massachusetts...	35
Lowell-Lawrence, Massa- chusetts.....	40
Springfield, Massachusetts...	25
New Haven, Connecticut.....	25
Hartford, Connecticut.....	25
Providence, Rhode Island...	30
New York, New York.....	70
Plainfield, New Jersey.....	34
Newark, New Jersey.....	34
Durham, North Carolina.....	50
Winston-Salem, North Carolina.....	50
Lewiston, Montana.....	6
Portland, Oregon.....	50
Klamath Falls, Oregon.....	75
California:	
Average for state.....	52
Bay area.....	56
San Joaquin Valley.....	60
Southern California.....	49

* All data except those for California areas are based on estimates received from milk control officials or industry representatives in reply to mail surveys, collected and compiled by R. G. Bressler, Jr., and refer to January, 1950; California data from California Crop and Livestock Reporting Service, "Dairy Information Bulletin" (Sacramento, January, 1956), vol. XII, no. 10. (Data for October, 1955.)

per cent of the fluid milk sales. In each of the following markets, the three firms with greatest volumes accounted for these percentages of total sales: Fresno, 59; San Francisco, 59; San Diego, 44; Alameda-Contra Costa, 47; and Los Angeles, 35. (That this degree of concentration is neither unique to California nor a result of a tendency toward "big business" in recent years is borne out by similar percentages for the three leading distributors in other areas during the 1930's: Boston, 64; St. Louis, 69; and Phoenix, 84.) On the other hand, there are nearly 500 licensed distributors in California, nearly half of which do business in the above-named markets of the state.

In spite of scale economies and the fact that some corporations operate on a regional or nationwide basis, fluid milk distribution is primarily local in nature. This results partly from the bulk and perishability of fluid milk—transportation over long distances is expensive relative to value—and partly from artificial trade barriers. Early in the development of commercial milk distribution, health officials became alarmed over the number of epidemics which could be directly traced to bacteria in milk. As a result, local ordinances and state regulations were passed in an effort to control the quality of the milk supply. Many of these, although reasonable at the time, are no longer important in safeguarding the health of local consumers. Instead, they have developed into trade barriers which protect the financial health of the local industry. Many communities have ordinances which require pasteurization within the city limits. A full coverage of the types of restrictions to the free flow of milk between areas is beyond the scope of this study, and has been discussed by others (see 7, 8, 11, and 14). The point to be made here is that these devices have served to "protect" the local nature of fluid milk markets.

As previously stated, the typical organization of the industry within a market involves a few dominant distributors with the major share of the volume and a relatively large number of small distributors which handle the balance. While in the business sense the fluid milk industry tends to be intensely competitive (that is, firms expend great efforts to win customers from their rivals), the structure and organization of the market differ significantly from the economist's conception of "pure" competition.

In this industry, therefore, "free enterprise" does not have the same implications as "free competition." The former tends toward expensive advertising outlays designed primarily to attract business away from rivals, and the provision of costly services which, in themselves, are not necessarily desired by consumers *at the price* which must be paid for them. In most cases, consumers do not have the opportunity to make a rational choice among service combinations since the additional costs of new services may be temporarily absorbed by the firms which have initiated them. To the extent that a device is effective in attracting customers, all firms are forced to follow suit, and such services become a part of the "normal" operations. The additional costs must sooner or later be recouped from the consumer if the industry is to continue to operate in the long run.

At times, free enterprise in an industry organization such as this takes the form of "price wars." While generally welcomed by consumers, who may obtain short-time price benefits, price wars are usually precipitated to force weaker firms out of business and thus provide greater monopoly power for the remaining firms. Viewed from this standpoint, price controls administered in the public interest *could* do much toward improving the efficiency and lowering the costs of industry operation.

Pricing Procedures and Policies of the Bureau of Milk Control

Beginning in 1935, with the passage of the Young Act, and supplemented in 1937 by the Desmond Act, prices for fluid milk in California have been established by an agency of the state government. The historical origins of government price control have been covered elsewhere and will not be repeated here (see 5 and 12).

At present, 37 separate marketing areas are established in California. Virtually all of the Class 1 sales (which in California include both fluid milk and fluid cream) are covered under the fluid milk pricing provisions of the control act. The provisions establish producer prices, prices for interdistributor sales (including the sales of processed and bottled products to subdistributors), and wholesale and retail minimum resale prices. The latter involve a schedule by type (such as standard grades, premium grades, and cream in areas where a cream plan is in effect) and by container sizes.

The provisions of the law, as they appear in the Agricultural Code, specify the types of prices to be established, and generally outline the procedures to be followed in determining the level of those prices. In arriving at minimum resale prices, a factor to be considered is that, in addition to the raw product cost (the price paid producers—also established by the state), such prices “will tend to maintain in the business of distributing fluid milk and fluid cream, or both, such number of reasonably efficient retail stores and distributors of fluid milk or cream, or both, in such marketing area as the director finds is necessary to insure to consumers in such marketing area sufficient distribution facilities of the several types or methods commonly used by consumers” (Art. 10, Ch. 17, Div. 6).

At the time that the control program was enacted, it was recognized that the pressures within the industry which had previously broken out in the form of price wars would tend to take other forms. For this reason, the legislation providing for minimum resale prices also specifies a number of unfair trade practices, the use of which is punishable under civil law. These unfair practices include price rebates or unearned discounts, and the giving away of any products, services, or articles of any kind for the purpose of securing the fluid milk or fluid cream business of any customer. In this manner, both direct and indirect price reductions are prohibited. (For a list of unfair trade practices, see Appendix C, p. 76.)

The Bureau of Milk Control—the agency administering price control in California—makes periodic audits of distributor records to determine distribution costs. These, in turn, are used as guides in establishing resale prices. Cost studies of sample plants are carried out at relatively frequent intervals. In addition to these regular studies, revisions are frequently made on the basis of major cost changes (such as a new labor contract or adjustments made in the price schedules for containers and other supplies).

Most of these analyses are made by Bureau of Milk Control personnel through an audit of the financial records of individual distributors. Under the law, the distributing firms are required to turn over to the Bureau accountants any and all materials necessary to ascertain accurately the costs experienced and the volumes of sales. Furthermore, in making studies of costs, the Bureau personnel frequently apply “efficiency fac-

tors" in order to arrive at the so-called "reasonable costs" which are used for pricing decisions. For example, an efficiency factor might be a standard rate of performance or a "reasonable" size of delivery route volume. For plants not meeting this rate of performance, costs

are calculated as they would have been if this rate were achieved. Other adjustments are made in these computations, such as the prorating of lump-sum expenses—for example, the purchase, at one time, of a large supply of bottle caps—over the period of time under study.

Relation of Costs and Prices

Under conditions of a perfect market (see 3 and 9), the allocation of resources, the volumes of the various goods and services produced, and the product and factor prices are all determined simultaneously. These solutions are achieved through the operation of free choice on the part of the consumer and a freely competitive productive system—reflecting the basic or ultimate resource and technological limitations. Under this system, prices would equal costs (in the long-run sense), including normal profits and the inherent determination of appropriate rents and other factor prices.³

This perfect market system would be *economically efficient* in that no changes in organization could be made which would increase the welfare of *all* individuals in the society. Economic efficiency, however, is only one of the factors contributing to the social welfare. Thus, Congress may adopt measures designed

to increase farm income at the cost of the income of the nonfarm segment (see 4). In the same way, there may be an instinctive reaction to protect the small businessman and "preserve the American way of life." Society may, in some cases, choose to provide a subsidy rather than let this form of economic life die out. Such subsidies may take the form of some type of "protection" from lower cost competitors. When such protection exists, it takes the form of "income transfers" (taking from one group and giving to others). Note that such income transfers are not necessarily incompatible with an efficient allocation of resources, but that often the "means" selected to effect such transfers are those which work through the pricing system, with consequent distortions in resource use.

In this instance, as in any other, the sacrifices involved in such decisions—that is, the corresponding loss in economic efficiency—must be recognized if choices are to be made intelligently so that costs are weighed in relation to gains. Determining milk pricing systems that adequately reflect the nature of costs will (1) provide a basis upon which milk prices *could* reflect cost differentials and so approximate perfect market prices, and (2) indicate the costs of subsidizing certain elements in milk distribution by suggesting the nature of the alternative and economically efficient organizations and the savings which would accrue with reorganization.

³ This would be true only in circumstances which approach those of perfect competition—that is, perfect knowledge on the part of both buyers and sellers, homogeneity of product, and an atomistic organization of the industry. Where scale economies which are incompatible with an atomistic structure prevail, a rule that entrepreneurs equate marginal cost to price (rather than to marginal revenue) is required to meet the condition of price equals cost. While this poses some perplexing problems anent the organization of the industry and its regulation, the point to be made here is that such an "ideal" system would result in a *set of prices* consistent with an economically efficient allocation of resources.

Impact of Flat Pricing Under Conditions of Differential Costs

It has long been recognized that it costs less per unit to deliver a large order of milk than a small one. This applies both to wholesale and retail milk distribution, and is convincingly brought out through a comparison of the results of the processing and distribution cost studies made by the Bureau of Milk Control. A survey in the Los Angeles market showed that total distributor's expense for wholesale sales of milk in fiber containers had a range of over 2½ cents per quart (\$0.026522) between the highest- and lowest-cost firms. This survey covered the period August through November, 1952, the latest date for which the firm serving the very large volume customers was included in the study. (More recent cost studies have been made of other firms in the Los Angeles area.) Further inspection indicates that the largest part of the expense difference (\$0.013789) occurs in the single item of delivery cost. The high-cost firm spends nearly four times as much per quart in getting the milk from the plant to the customers as does the low-cost firm. Cus-

tomers of the high-cost firm average about 60 units per delivery; those of the low-cost firm average nearly 2,400 units. While this example is extreme, the records of all firms studied indicate a definite tendency for delivery costs per unit to decrease as the average volume per stop increases.

The Bureau of Milk Control for many years has set minimum resale prices which have been uniform among customers. It made no provision for discounts or other allowances for the differential costs involved in serving different types or sizes of delivery.⁴ As in almost every instance of arbitrary price controls, pressures have resulted which are directly attributable to this flat price policy. The impact of these pressures was no doubt postponed in the early years of milk control because of the war situation and the accompanying restrictions and shortages. Such pressures were present, however, and have become increasingly important since the end of the war. Although stiff penalties have accompanied the relatively few violations that have been uncovered, it is highly probable that secret rebates, discounts, and discriminatory price advantages on nonpriced items have been granted to preferred customers.

⁴Some recent exceptions have been made to the uniform pricing policy. Late in 1952, a service-charge system was established for retail deliveries in the Alameda-Contra Costa marketing area. At the same time, a ½ cent per quart discount on home-delivered sales in excess of 60 units per month was adopted in several southern California markets. A 5 per cent discount was also allowed on sales to schools and other public institutions where sales of \$250 or more per month were made. In January, 1956, a new order was issued for the Fresno area, under which sales of milk in excess of a value of \$5 per delivery were subject to an 8 per cent discount. At that time, in that market, a service-charge system on retail home-delivered sales similar to that in the Alameda-Contra Costa area was established. At the time of writing, it is contemplated that similar orders will be issued for other markets in the state in the relatively near future.

The incentive for efforts to by-pass the provisions of the flat price schedules can readily be seen. Assume that the price set by the Bureau of Milk Control takes into consideration the delivery cost of the average-sized customer in the market. This average-sized customer represents many customers which are smaller than average and many which are larger. Under conditions where it costs less per unit to deliver a large volume than a small volume, the flat price set by the Bureau is inadequate to cover the costs

involved in stops smaller than average, and is more than adequate for larger than average stops. (The term "stop" will be used throughout to denote a single delivery to a customer.)

It might be argued, from the standpoint of the distributors' welfare (omitting for the time the effect upon consumers), that this is an equitable procedure, *provided* each distributor has the same proportionate share of large and small deliveries. The margin established by the Bureau should be sufficient to cover the cost of a reasonably efficient distributor in serving stops of average size; thus, all distributors would be treated fairly. If all distributors did not have the same size distribution of deliveries, then any individual firm with a greater than proportionate share of small stops—even if "reasonably efficient" in all other operations and in the organization of all factors under its direct control—would find it difficult to operate within the price spread based on costs for the average size of delivery in the market.

Flat pricing under circumstances of differential costs raises a serious equity problem between different customers. When a procedure is used which "averages out" the differential costs associated with varying volume categories, the small-volume customers are obviously being subsidized by the large-volume stops.

The uniform price system in California markets has had two major effects. In the first place, it has decreased the efficiency of the milk distribution system. Since volume-cost differences are not reflected in price, individual customers find no monetary incentive to place their total order with a single dairy firm. Rather, so long as supplies are plentiful, the customer—particularly the grocery store—is under some pressure to divide his trade among several distributors, thus taking advantage of consumer brand preferences. These split stops—also ob-

served in home deliveries—of necessity reduce the average volume of delivery in the market and so increase the distribution cost.

The second effect of flat pricing has been the rather elaborate procedures by which wholesale customers become attached to particular milk distributors. Among the more extreme devices which may be substituted for a price incentive in order to keep a set of particularly desirable wholesale outlets are those familiarly known as the "captive creamery" and the "captive supermarket." A captive creamery is a milk processing and distributing concern whose capital stock is held by the owners of supermarkets to whom its products are sold. A captive supermarket involves the reverse ownership pattern—in this case, milk distributors hold stock in supermarket corporations. The idea, essentially the same in both instances, is to form an attachment between the milk company and the more attractive of the wholesale customers in such a way that the profits resulting from the economies involved in sales to these customers can be "captured."

The development of the captive creamery stems from the realization, on the part of large-volume, low-cost outlets (mainly supermarkets), that substantial savings are involved in making large deliveries. Savings of this same type exist in many other commodities, and explain, in large part, the success of the supermarket movement. By buying in large quantities and by selling large volumes with a rapid turnover, the per unit cost of distribution is reduced. With milk in California, however, these large-volume outlets are forbidden, by the legally established uniform prices, to participate in these benefits. As customers, these outlets cannot share in the profits to the distributor for which they were, in fact, responsible. As owners—stockholders in the milk processing corporation—they can participate in the profits. The operation of captive creameries, their eco-

conomic justification, and their importance are well illustrated in the following article quoted from the *Milk News Weekly* (October 15, 1954):

Supermarkets Offered Stock in Creamery

San Francisco, Oct. 11 [1954]—An independent wholesale milk distributor has offered to sell up to 49% of its corporate stock to a dozen supermarkets in this area for the purpose of doubling the creamery's sales and permitting the markets to participate in the savings made possible by volume distribution, it was reliably reported here today.

Details of the plan require 75% of the market's dairy products purchases to be from the distributor. In return, the market would be allowed to purchase stock up to $\frac{1}{3}$ of their monthly billings. It is estimated that the dividends would clear the cost of the stock in a few months, and thereafter, dividends would amount to between 1¢ and 1 $\frac{3}{4}$ ¢ per quart of milk. The distributor's capitalization would permit participation of about 18 supers taking 40 cases of fibre quarts per day, it is estimated.

The action seeks to match the economies enjoyed by chain store captive creamery delivery trucks which set off high volume loads, which have led to the claim "we could sell milk to consumers for less if permitted by state law."

The creamery's proposal also envisions the addition of ice cream and bread lines in order to meet chain store consumer prices which are consistently lower.

Market participation in creamery margins are [*sic*] already in operation in Los Angeles, with the possibility of another offer under consideration in Oakland, it was reported.

It is small wonder that, under circumstances of this sort and especially where a sufficient number of large supermarkets exist to make the operation feasible, the captive creamery has become a factor of increasing importance. Annual reports of the California Department of Agriculture show that in Los Angeles, for example, one milk company, a wholly owned subsidiary of a large grocery chain, began operations in 1929. A similar organization controlled by another grocery chain was first licensed to process and distribute market milk and market cream

in 1932. These concerns supplied the stores within their chains exclusively and so were the original captive creameries—in the sense that the ownership of the milk distribution and store enterprises was identical. No other milk distributor could hope to acquire the patronage of the retail stores within these chains unless consumer preference for the particular brands of "outside" distributors should force the chains to handle other than the "sponsored" brand.

Two similar developments have occurred more recently in the Los Angeles market. In 1941 and 1948, two other milk processing and distributing firms were established, in both of which a substantial part of the capital stock was owned by individuals who also operated supermarkets, even though the markets themselves were owned independently. Both firms specialized in the sale of milk and dairy products to large-volume stores for resale to consumers. The growing importance of the sales of these four specialized distributors—the two chain-operated and the two independent, supermarket-operated—is shown in table 3.

In a move to counteract the tendency for large-volume, wholesale customers to become affiliated with captive creamery operations, several of the larger independent milk concerns are reported to have made substantial investments in supermarkets in an effort to gain the power to influence the purchase policies of these establishments.⁵ In addition to the captive creamery, therefore, there has developed the captive supermarket. The importance of its effect on the milk industry is much more difficult to determine than is that of the grocer-owned milk concerns, because independent milk

⁵ The following news item appeared under a Los Angeles date line of August 15, 1950, in a dairy trade journal:

Joint announcement was made at a press luncheon today by Blair Holdings Corp. and Golden State Co., Ltd. (a milk distributor) that the recently-formed subsidiary, Western Industries, Inc., has entered into

Table 3. Estimated Total Sales of Market Milk Through Stores in Los Angeles, and Sales of Four Specialized Milk Companies, 1944-1955

Year	Estimated sales through stores*	Sales of four "captive" companies†	Four companies' percentage of total sales
	thousand gallons of market milk		
1944.....	53,992	7,617	14.1
1945.....	58,316	8,215	14.1
1946.....	59,837	9,478	15.8
1947.....	59,010	9,231	15.6
1948.....	59,265	10,971	18.5
1949.....	57,929	10,974	18.9
1950.....	57,600	11,830	20.5
1951.....	61,732	13,160	21.3
1952.....	66,845	14,769	22.1
1953.....	74,718	15,988	21.4
1954.....	73,196	16,531	22.6
1955.....	77,127	17,382	22.5

* Estimates for 1944-1948 and for 1951-1954 are from "Sales of Fluid Milk by Type of Trade and by Size and Type of Container," annual reports of the California Crop and Livestock Reporting Service covering sales for the month of October each year. These estimates were derived from the wholesale sales of milk in quart and half-gallon fiber containers. As no records are available for sales by container size for the period 1948-1951, estimates of store sales in 1949 and 1950 were made on the basis of what percentage of total wholesale sales during 1948 was store sales.

† From records of the California Crop and Livestock Reporting Service. Includes sales of only three companies before 1948.

distributors are not required by law to keep records of sales to individual customers. In addition, the distributors so involved would be loath to release information of this type for fear of retaliation from rival distributors.

The additional sales acquired by customer-owned companies have been made up almost entirely of customers handling large volumes. This seems reasonable in view of the fact that such outlets can be served at low cost—the main incentive for this type of organization. Further-

an agreement to acquire the Jim Dandy super market chain in Los Angeles. The five super markets in the chain with an annual gross sales in 1949 totaling \$7 million, will become the first asset acquired by the Blair-Golden State subsidiary.

(From *The California Milk News* (Los Angeles: August 18, 1950), vol. XXXVI, no. 21. The name of this publication has since been changed to the *Milk News Weekly*.)

more, in reflecting cost savings back to the owner-outlets, such distribution firms have been able to make additional savings by reducing delivery services. For example, deliveries may be made only to the store loading dock; the milk products are then carried into the store by store employees whose wage rate is lower than that of the route drivers. As a matter of fact, these operations often may be carried on without increasing store personnel.

Both outgrowths of the flat pricing procedure—the tendency for a greater proportion of split stops and the growing importance of the captive creamery—have reduced the average size of delivery by the independent distributors. It is interesting to note that the effect of the captive creamery has actually been to improve the efficiency of distribution so

far as these captive firms and their affiliated outlets are concerned. As distribution firms of this type have expanded into the large-volume stops, the average delivery per customer has fallen off for

the remaining firms. Furthermore, these low-cost outlets are kept from taking full advantage of their cost position by the establishment of out-of-store prices which are also maintained on a flat price basis.

Alternative Price Plans

Flat pricing, as discussed above, does not reflect differential costs adequately. Furthermore, it is inequitable, discriminatory, and fails to provide an incentive for more efficient and economical distribution. It also encourages certain practices, including secret rebates and the growth of captives. Two systems are considered as alternatives to this type of pricing procedure.

Service charges. This system involves two-part payment for delivered milk—first, a fixed charge per delivery, and second, a uniform price per quart delivered. Naturally, since a part of the payment is in the form of this fixed, or service, charge, the uniform price under this system is lower than that under the flat price procedure. The volume pricing effect, of course, stems from the allocation—or “spreading”—of this fixed charge per delivery over the number of units delivered.

Under current California cost conditions, a service charge system involving a 35-cent charge per delivery plus a uniform price of 17.1 cents per quart for volumes less than 221 labor units, coupled with a charge of \$1.43 per delivery and a uniform price of 16.6 cents per quart for deliveries of more than 221 units, would closely reflect costs for wholesale sales. This schedule would be consistent with returns under the present flat price system of 17.5 cents per quart. (A more complete discussion of how these schedules were derived, and of the relation of these prices to costs is presented beginning on page 63.)

In a similar manner, a retail service

price schedule of 10.5 cents per delivery, with a uniform price of 18 cents per quart, would closely approximate costs of home-delivered milk. This schedule would provide returns comparable with a flat price system of 21.5 cents per quart. (The development leading to this proposed retail schedule is discussed beginning on page 63.)

Volume discounts. While necessarily less accurate than a service charge system, volume discounts can be developed which are greatly superior to flat pricing in reflecting differential costs. An almost infinite number of discount schedules can be devised. As an example, one schedule for wholesale sales has been arbitrarily chosen to illustrate the mechanics of volume discount arrangements, and is later compared with the cost-volume relationship. This particular schedule involves four classes and a “base” price of 19 cents. At each class—or “bracket”—a progressively increasing percentage discount (ranging from 8 to 12) applies to the total milk purchases.

The pricing agency has been adopting a somewhat different volume discount procedure in those California markets where volume pricing is being initiated. Here, a single discount figure applies to all sales in excess of a stated volume. For example, the schedule currently in effect in Fresno involves a base price of 17.5 cents per quart with a discount of 8 per cent on all milk sales in excess of \$5 value per delivery. (The effects of both types of volume discount schedules are considered more fully beginning on page 64.)

Differential Pricing Systems in Other Areas

It is difficult to discover the extent and nature of similar pricing plans in markets outside California. Most major markets do not have resale price control, and prices—especially to large and attractive wholesale customers—result from negotiations between buyer and seller. That discounts are given to large-volume, wholesale customers in uncontrolled markets is evidenced by the fact that such discounts were common in the Los Angeles market before resale price control. Spencer (10), in a study of this market in the summer of 1930, made the following statement: "A considerable proportion of the wholesale milk, both bottled and bulk, is sold for less than the quoted prices. Wholesale customers who take a large volume of milk and cream most often receive a discount or rebate. . . . This does not apply to groups of chain stores, restaurants, or confectioners, the individual units of which may not take any larger volume than independent stores or restaurants which receive no discount." He goes on to say that it is impossible to eliminate such discounts. "Buyers that take a large volume of goods are such attractive customers that even if all established distributors agree to eliminate discounts, others would come in to take advantage of the situation."

Some available information on the extent of open and established discount pricing in retail deliveries appears in

monthly market information reports issued by the United States Department of Agriculture. According to the January, 1956, *Fluid Milk and Cream Report*, discounts were given to large-volume retail customers in 39 out of 137 markets in the United States reported for that month. The delivery volumes at which these discounts become effective differ between markets, and the discounts amount to either 1 or 2 cents per quart. Although this report provides no information which would indicate the existence of discounts on wholesale deliveries, it is well known that such discounts do exist in many markets.

One of the differential retail pricing systems in current use is the so-called "Elwell Plan" (6). Named for the man who headed the distributing firm which initiated it, the plan has been in operation in the Minneapolis market since 1938. As it operates at present (January, 1956), its essential feature is a service charge of 4 cents per delivery, reflected in a price of 23 cents for the delivery of one quart plus a price of 19 cents per quart for all additional quarts in the same delivery. (If costs in Minneapolis are consistent with those determined in California, however, the 4-cent service charge is too low to reflect cost differences accurately.) According to popular reports, this plan has been well received by both consumers and distributors.

Potential Savings Through Volume Pricing

Pricing plans such as those discussed above could not be introduced without impact on the industry. Lower net prices would encourage wholesale customers to

consolidate their orders and to limit the number of dealers from whom they purchase milk. Retail customers, on the other hand, would be discouraged from de-

veloping "split stops"—that is, obtaining every-day delivery by getting milk from each of two distributors on alternate days. Furthermore, customers receiving home delivery while supplementing their milk purchases at groceries would be encouraged to take all of their milk from one source or the other. Such consolidations would mean a real increase in efficiency for the market as a whole, which would be reflected in lower average costs of distribution and in lower average gross incomes for distributors.

Just how these price changes would affect individual distributors would depend on what changes occurred in the number and average size of their customers. Immediate route reorganization would be required, permitting route consolidations to take advantage of the increased load sizes possible with larger customers. Although the exact nature of the changes cannot be predicted without actual experience, the potential savings resulting from consolidation of the entire milk market can be estimated.

Savings in wholesale distribution. The duplication involved when a wholesale customer is served by more than one distributor can be reduced either by administrative order (as during World War II) or by a pricing system in which the economies of large-scale deliveries encourage purchases from a single distributor. Wholesale customers of the independent distributors included in the Los Angeles sample study of 1950 (see p. 19) received dairy products from an average of 1.71 distributors. The average volume per delivery per company amounted to 77 labor units. Where each customer is supplied by a single distributor, the average size of delivery would thus be increased to 132 units. On the basis of the developed cost relationships, this would mean that route volumes could be increased 26 per cent, resulting in a 19 per cent saving in unit delivery costs. This 26 per cent increase would permit a 20 per cent decrease in number of

routes, holding total market volume constant at the current level. Since duplication exists primarily in grocery stores rather than in the other types of outlets, the savings in terms of stops of this type would be greater than the over-all averages presented here.

The savings to be expected in other markets depend, of course, on the existing degree of duplication and the present average size of deliveries. Within the city limits of Fresno, the average number of distributors per grocery is 3.14, and the average volume per stop amounts to approximately 45 labor units. The average volume per grocery for this market, therefore, is over 140 labor units. A complete reorganization of the market, with each customer receiving from only one distributor, would permit an increase in load sizes of more than 65 per cent. This increase in route volumes could allow a reduction of 40 per cent in the number of wholesale routes, and about the same in the unit costs of delivery operations.

Savings in retail distribution. No current data are available that would indicate the probable effects of a volume pricing system on the average volume per stop and, in turn, on the costs of retail delivery. Assuming, however, that the average volume per customer was increased by 1 labor unit per serve (an increase from about 3 units to 4 units), certain conclusions can be drawn. (The assumption is based on the existence of an incentive for very small customers to switch to store purchases, large-volume customers otherwise purchasing from stores to switch to home delivery, and for "split stops" to be consolidated.) Such an increase in average volume per serve would allow an increase of 25 per cent in route volumes at a corresponding reduction of about 20 per cent in the number of routes operated and in the unit costs of retail delivery. In this case, under current cost levels, the saving in delivery cost would amount to nearly 1 cent per quart.

Potential Savings Through Reduced Services

In addition to savings which can be made through consolidation of deliveries, economies in the distribution of milk could also be brought about by reducing the number of services provided. During World War II, special deliveries and special call backs for collection were eliminated, and retail delivery was put on an alternate-day basis. Furthermore, on wholesale milk routes, the order had to be specified in advance. Some of these wartime practices, such as every-other-day home delivery, were continued after the emergency, but other services were restored when supplies of milk and manpower became more plentiful.

Table 11 (p. 35) shows the direct delivery, time-volume relationships for alternative types of services and points out the reduction in time per customer, for any given volume, that would accompany the elimination of certain operations. Thus, delivery type "A" represents the full set of operations typically performed by wholesale route drivers at present, type "B" stipulates the elimination of the "secure order" and "collect" operations, and type "C" specifies a set of minimum operations, including a set-off delivery at the sidewalk or platform. Many other types of reduced service combinations can be visualized and could be handled equally well.

The effect of the reduced direct delivery time on permissible route organization has been calculated for these two additional types of deliveries. The resulting route volumes compatible with an eight-hour route day under the alternative delivery types are shown and compared with the full set of delivery services in table 19 (p. 66). In addition, the table also shows the corresponding influence on unit costs under current cost rates.

As can be seen, substantial gross monetary savings in truck and delivery labor costs could be accomplished through a reduction in the amounts of services provided. For the average sized stop, a 37 per cent reduction in costs would result from a situation in which the order was known in advance by the route man, and collection was made by mail. This saving is increased to 52 per cent if, in addition, the products are set off at the sidewalk. The net savings would, of course, depend upon the additional costs involved when the customer phones in his order, on the extra bookkeeping and clerical work required for handling the mail collections, and on the increase in store personnel required to bring the dairy products into the store from the sidewalk.

Possibly more important than the monetary savings, at least in times of critical manpower shortage, are the labor savings that may be achieved under these alternative systems. In addition to the possible savings in manpower through consolidation of deliveries, the productivity *per route driver* could be increased by 69 per cent and by 138 per cent, respectively, under the limited service types of delivery combinations described (p. 35).

The magnitude of the cost differences, plus the fact that cost functions applicable to these reduced services can be determined, suggests that a pricing system could be devised which would reflect these differential services. Under a service-charge system of pricing, the costs (delivery costs plus other, nondelivery costs) of type "B" services could be adequately reflected for delivery volumes under 200 units by a charge of 18 cents plus 16.75 cents per quart. For type "C" services, for the same range of volumes,

a charge of 12 cents plus 16.65 cents would be sufficient. These compare with similar charges for type "A" services of 35 cents per delivery plus 17.1 cents for each quart delivered. It should again be

noted that these figures do not allow for added costs—such as bookkeeping—in-curred by the distributor nor do they include estimates of the added cost of services provided by store personnel.

Differential Pricing at the Consumer Level

All of the preceding discussion of pricing wholesale sales has been in terms of prices paid by customers—or the "in-store" price. The question then arises as to how such savings will be passed on to the ultimate consumers under circumstances where, as in California, resale prices are established by public authority. The direct answer to this obviously depends on the attitude and action taken by the control authority. At least three policies are possible. First, the Bureau of Milk Control, having established a differential pricing system reflecting delivery costs at the in-store level, could decide to do nothing about the consumer price and could continue to set uniform out-of-store prices on the basis of average costs for the market plus a flat store margin. (The latter is the difference between the consumer price and the price paid by the wholesale customer.) Second, an intensive analysis could be made of the unit costs of store operation, and the consumer price could be based on a variable in-store price and variable store margin for different types and sizes of stores. Third, since the Bureau is directed to establish only *minimum* prices, a "stop-loss" price could be established, based on the *most efficient* combination of delivery and store operations. Under any procedure, consumer prices in higher cost outlets would be free (so far as the Bureau is concerned) to depart from the minimums in an upward direction, and thus reflect the added costs of the extra services and conveniences. Carried to its logical extreme, the latter procedure

would eliminate the "fixing" of store margins, but would possibly keep the wholesale customer from selling to consumers at prices less than the in-store delivered cost.

Uniform store prices. Under this policy, consumers would gain somewhat over a period of time. To the extent that consolidations take place and the duplication of delivery services is eliminated, the efficiencies so gained would be reflected in average delivery costs. In turn, these savings could eventually be reflected in lower established prices. Furthermore, society as a whole would gain through resource use conservation since milk delivery would require fewer men and less truck resources when the route reorganization possibilities were fully exploited. This alternative, however, has obvious disadvantages. First, it would provide inequitable margins among stores. Large-volume outlets would receive high margins and small-volume stores would receive small (and conceivably even negative) margins. (This presumes that small stores do not increase out-of-store prices above the minimums established, which, of course, they are legally free to do.) Note that, from the standpoint of the storekeeper, this is an exaggeration of one of the limitations of the flat pricing system. Second, the strongest argument against this procedure, from a social standpoint, is that it does not provide the ultimate consumer with an incentive to select the most efficient system of satisfying his desires—that is, the combination of services which

yields the greatest amount of satisfaction relative to cost.

Differential store prices. This procedure is theoretically possible. Furthermore, it is entirely logical that margins charged by large-volume stores reflect the lower unit costs of doing business through outlets of this size. However, it would be almost impossible to make such a study which would adequately represent the “true” level and nature of such costs. Not only would it involve a highly complex problem of multiple products and multiservices, requiring allocation of joint costs among hundreds of items; it would also require consideration of such factors as the drawing power of certain items. For example, how much drawing power do fresh milk and bread have in attracting customers to a store where, once inside, they may buy additional items? In spite of these limitations, it is quite possible that information on the direct costs of handling milk in these outlets could be obtained. This information would prove helpful in determining the variations in direct costs associated with different types and sizes of retail stores. Studies of this type have been carried out by the Bureau of Milk Control in the past and have been used in determining the

prices established at the out-of-store level. Furthermore, this type of pricing system would resemble the procedure used by the OPA during World War II in setting retail price ceilings by class of stores—which generally reflected differences in sales size.

Uniform store prices based on efficient levels of operation. This policy of establishing a price “floor” based on the most efficient combination of delivery and store operations appears to be a practical procedure. Of course, it represents a near approach to complete decontrol of prices at this level. Through this system, the “dangers” of price wars resulting from aggressive store merchandising policy are minimized since the burden of the price wars could not be shifted back either to producers or distributors as it is assumed that prices at these levels would continue to be established and enforced by state agency. Furthermore, the additional costs of the added convenience and services of the small-volume grocery would be allowed to find their own level, and consumers—with the exercise of free choice—could then be effective in determining the system that provides them the greatest net gains.

Scope and Procedure of the Analysis

The marketing of milk consists of a series of services. Although the physical composition of the product is not basically altered in most cases, the great bulk of fluid milk must be collected or assembled at country points, transported to urban consuming centers, processed to some extent (pasteurized, standardized, and bottled), and delivered from the processing plants to stores and homes.

Since several services are involved in milk marketing, and especially since all of these services need not be performed

by the same corporate entity, it is convenient to deal with the various aspects separately. Following this procedure, country assembly and transportation may be studied. When this is complete, analysis may be made of the operation of processing plants. From this then follows an investigation of delivery costs. When all of these aspects have been studied, they can then be brought together into an analysis of the whole system—since each of these operations is essentially independent, and the system as a whole

consists of a combination of the separate parts.⁹

Operating on this premise, this study is undertaken as a detailed and intensive analysis of milk delivery operations. Plant operations and the services performed between the wholesale customer and the ultimate consumer are not included. Intimate details of the functional relationships of a single phase of milk marketing are provided in such a way that they will be useful not only in determining means of improving efficiency in this phase, but also in providing measures which can be included in an analysis of the system as a whole when more complete information on other phases becomes available.

The present analysis has three objectives: (1) to determine the costs of delivering milk and milk products and to determine and measure the influence of the major cost-affecting variables; (2) to contrast these results with various pricing plans and so determine the type and nature of pricing systems which will adequately reflect costs; and (3) to determine the nature and effect of savings that might be realized through the reorganization of milk deliveries. Furthermore, the specific application of all phases of the analysis will be confined to the major California markets although tests will be applied to determine the general applicability of the results to other areas.

Milk customers—in addition to home-delivery ones—include grocery stores,

⁹ Such interdependencies as exist in the aggregate stem from the fact that the long-run average costs for the whole system reflect the compensating influence of the simultaneous existence of economies of scale in one of the parts (for example, processing plant operation), and diseconomies within another (for example, through increased transportation requirements). The separate aspects are independent, however, in the sense that the *relationships* that determine physical inputs and costs are unaffected by the realized volume in any of the other components.

restaurants, drugstore fountains and soda bars, schools, institutions, and commissaries. Conditions of delivery vary widely within these classifications. Groceries include large, modern supermarkets handling great volumes of all commodities, including milk, as well as the neighborhood store where the quantity of milk purchased from one distributor each day may more closely resemble the volume of a single retail delivery. While not of the same magnitude, similar discrepancies exist in the volumes received per delivery within the other categories. One of the major aspects of this study is a consideration of the influences of variations in the volume per stop on delivery costs.

Furthermore, differences exist in the number of services provided for the customer, particularly by the wholesale route driver. Since these, in turn, influence the costs involved in making the delivery, the effect of differential types of wholesale delivery services is also considered.

As has been frequently observed, one of the "wastes" involved in our present system results from the duplication of marketing services. The majority of wholesale customers receive dairy products from more than one distributor. Studies made by the California Bureau of Milk Control during 1950 show that the average number of distributors serving groceries in Los Angeles was 2.10; in Stockton, 2.47; and in San Francisco, 3.53. A 1954 study in Fresno showed that groceries were being served by an average of 3.14 distributors. The effect of such duplication will be measured by making estimates of the possible savings (in terms of money, manpower, and equipment) through a consolidation in which each customer is served by a single distributor. Although brand names and advertising are used to increase the demand for specific brands, fluid milk and dairy products tend to be closely standardized and undifferentiated in physical

composition. Certain sanitary regulations limit the bacteriological content of the products, and legal standards with respect to minimum milk fat and nonfat solids content for the most part also determine the maximum amounts which will be sold per unit of product. Actually, very little difference can now be found among the products sold by individual distributing firms. In spite of physical

homogeneity of the products, however, it is possible that consumers' attitudes may be such that they would be willing to pay for the opportunity to make a choice among various brands or packages. Data on the cost of duplication, therefore, will provide a basis for intelligent decisions relative to the "value" of being able to choose among products of different firms.

Theoretical Framework of Analysis

Determination of costs. The two basic costs involved in the delivery of milk are for truck operation and the payment for labor. The magnitude of these costs depends on: (1) the levels of inputs of truck resources (such as gallons of gasoline and quarts of oil) and of labor resources; and (2) the cost rates appropriate for these various inputs during the time period under consideration.

The physical inputs of these resources are not fixed on a route-day or a unit basis, but vary according to the conditions of route organization. Thus, it does not cost so much to operate a small delivery truck as it does a large trailer van. Fewer inputs are required to operate a route 10 miles long than to operate an identical type of route 100 miles long. Furthermore, the various labor requirements in the over-all delivery operations are not independent. When the route driver works for a specified time period, the amount of time he spends in driving between customers and to and from the plant will affect the amount of time remaining for delivery and, in turn, the number of customers that can be served during the day. It is therefore necessary to know the nature of these relationships.

The theoretical model in a study of costs of this type is drawn from production economics. The production of delivery services requires the use of productive factors—labor and the various resources involved in truck opera-

tion. When rationally applied, varying amounts of inputs of these labor and truck resources will result in different levels of outputs of delivery services. These outputs of *delivery services* are in themselves multiple products, however, which *combine* the amounts of the products delivered, distance, and the associated direct services. Furthermore, these direct services are multidimensional in that they involve alternative combinations of operations. The question of the cost of delivering a quart of milk, then, must be answered in terms of these attributes of the *service output*. Thus, instead of treating output as a function of inputs, inputs (such as labor) are expressed as a function of the output characteristics or dimensions. In this way daily route labor (time) will be a complex function of route distance, route volume, the number of customers served, volume per customer, and the type of service. This can be represented by the general function:

$$T = f(D, V, C, V_s, \dots, X)$$

where T represents the route labor time; D , the route distance; V , the total route volume; C , the number of customers served; V_s , the volume per delivery; and X , the type of service—or the number of operations performed for the customer. Some of these "independent" variables are closely interrelated. For example, C multiplied by V_s equals V .

Conventional problems of production economics deal with intensification upon a fixed factor and the technical conditions which give rise to diminishing returns. Thus, a machine may be operated at various rates of speed in order to arrive at an "optimum" rate. The present problem is not primarily concerned with changes in *rates* (that is, to make the man work *faster*) but with determining typical, or normal, performance rates. The volume of products delivered (just one of many dimensions of delivery service output) will be increased by changing the conditions of delivery or by working longer hours. This is reflected in the generalized time function shown above. Note that this is not a problem of diminishing returns in the usual sense since there is no intensification in the *rates* of input and output flows.

Since X —the type of service—is not a continuous variable, it will be appropriate to determine a separate time function for each type of service that will be considered. Each of these will then specify the functional relationship between time inputs and the route characteristics when the type of service is *held constant* and will take the form:

$$T = f(D, V, C, \dots, V_s)$$

The influence of the independent variables expressed in this equation is further complicated by the fact that, while D enters into time requirements only for driving time, C —the number of customers—may influence both the time involved in driving and also the time spent directly servicing customers. Thus, total time may be broken down, for analytical purposes, into relatively homogeneous elements. This might take the form:

$$T_t = T_1 + T_2 + T_3 + T_4$$

where T_t refers to total route time, T_1 to time spent driving, T_2 to time spent directly servicing customers, T_3 to time

spent at the plant, and T_4 to miscellaneous and personal time. Then each of these elements can be analyzed separately relative to the appropriate variables with the results:

$$T_1 = a + bC + cD$$

$$T_2 = d + eV_s$$

$$T_3 = f + gC + hV$$

$$T_4 = i$$

Summing these coefficients arithmetically, they form the total time expression:

$$T = (a + d + f + i) \\ + (bC + gC) + cD + hV + eV_s$$

a more specific form of the function.

In these expressions, a limit to output is provided by the number of hours that can be worked during a given period. Since virtually all milk routes in California operate on an eight-hour workday, eight hours can be used as a practical limit to daily capacity and therefore a maximum value—or cutoff point—for the time function. Expressing time in minutes, and substituting this maximum in the total function, result in the following:

$$480 = f(D, V, C, \dots, V_s)$$

In this form the function can be used to determine the effect of the interrelationships among the "independent" variables. Remembering that $V = CV_s$, analyses can be made to determine the interrelationships with D . Knowing the extent of *all* of these interrelationships, it will then be possible to show how changes in any one of the components (such as V_s) will permit changes in the others (such as V). With total route time fixed at 480 minutes, time per unit of volume (or per customer served) can be calculated by dividing 480 by V (or C).

Labor costs per unit of volume will then be the number of minutes required per unit, multiplied by the appropriate labor cost per minute or, as an equivalent, the labor cost per day divided by the total units delivered (V).

Truck costs can be determined in a similar manner. Although labor costs per eight-hour day in most California markets are constant—that is, they are not influenced by route volume, distance,

or number of customers—some positive relation between truck costs and volume will be expected because larger-sized loads require larger trucks. The influence of volume and/or number of customers and volume per stop can be considered in arriving at the total truck cost per day. Truck costs per unit are, then, the daily truck costs (which may be a function of volume and other of the attributes) divided by the daily volume.

General Procedures

The general procedure and form of the analysis have been specified in the previous section. Certain types of information are required in the quantification of the input functions. For example, it will be necessary to know not only that distance enters into the determination of route time requirements, but also *how* it enters. Data will be required on route characteristics, such as the mileages between various points, the number of interruptions and delays involved, and the resulting time requirements. Furthermore, details will be needed upon the number of different operations performed, the volumes delivered, and other variables which influence the amount of time spent servicing customers.

In many cases it will be impossible to establish an “ideal” formulation of a specific relationship. Some variables, although logically related to the operation under consideration, are extremely difficult to measure in quantifiable terms. An example of this might be the particular skill and ambition of an individual. Limitations of time and available funds are also important—both from the standpoint of obtaining, at one time, all the detailed information desired and also of going back to obtain further information on details which may have been originally overlooked. Such situations require either that further simplification

be made in the model, thus justifying the use of alternative or related variables, or that the differences in these elusive variables be ignored, and the results of the analysis interpreted to specify average or typical levels of such variables in the sample study.

When the data have been analyzed and the significance of the results tested, details of the relationships between input requirements and the corresponding outputs of the various aspects of delivery services—such as the influence of distance on driving time and of volume per delivery on direct service time—are known. These can then be combined—or synthesized—into an expression of the input requirements of the route as a whole. This provides the “hard core” of the analysis and, in fact, the end products of the empirical analyses. These results can then be applied to numerous practical problems which may arise. In this report, the application of these results will be limited to two interrelated problems, both of which have immediate and pressing importance. One of these concerns the economic pressures which arise from the administration of an arbitrary flat pricing system in California markets. The other concerns the potential savings in vital resources through changes in the organization of milk delivery systems.

Analysis of Time Study Data

Description of Data

Data were obtained on milk delivery route operations during the period 1950–1954. Wholesale routes were studied in all of the major markets in the state, including Los Angeles, San Francisco, Alameda-Contra Costa, Sacramento, San Diego, Fresno, and Stockton. Under the supervision of the Giannini Foundation, Bureau of Milk Control accountants—trained and experienced in making and recording time studies—rode and observed a total of 272 wholesale routes operated by 48 processing plants in these seven markets. In addition, detailed time studies were made on 113 retail routes operating in the Los Angeles and Fresno markets. A total of more than 8,000 individual customer deliveries was recorded for wholesale op-

⁷ The “sample” of routes covered, and upon which time observations were recorded, is not representative in the sense that the number of observations in each of the various size groups and types of outlets served which appears in the sample is proportional to the numbers in the universe as a whole. This is particularly true of the wholesale routes studied. The majority of wholesale milk deliveries are of relatively small volumes, which means that the frequency distribution of delivery sizes is not only skewed to the left but also “tails off” to the right, with only a small percentage of the total number of observations having large-volume deliveries. With a proportional sample, therefore, the fewness of cases in this high-volume range will result in substantially less reliability for this range for any given size of sample than will a sample which is disproportionately weighted by large-volume observations. For this reason, an effort was made to obtain as many large-volume delivery observations as possible. Each company studied was asked to supply a given number of routes to be observed and was further requested to provide those routes with the largest number of large-volume customers. The number of routes requested from each company roughly reflected differences in the total volume for each market handled per firm.

erations, while more than 18,000 customer deliveries were observed for retail home-delivered sales.⁷

For each individual delivery, all of the operations performed by the route driver were noted and the amount of elapsed time was recorded. In addition, the minute and hour were noted when the route man reported for work, left the plant, arrived at his first delivery point, completed the last delivery, returned to the plant, and made his returns for the day to the plant cashier. The time the day’s work was completed was also recorded. The mileage registered on the truck speedometer was obtained at the beginning of the day, at the first delivery, at the last delivery, and again when the truck returned to the plant.

Wholesale delivery observations.

At a typical wholesale customer service, the driver performs a series of separate operations. Quite frequently, he first walks into the customer’s establishment and determines the amount of products to be delivered. He may simply look over the milk and dairy products supplies remaining from previous deliveries or he may obtain the order direct from the manager. In some instances, of course, the driver may do both. Knowing the amount to be delivered, the driver returns to the truck and assembles the order. The next operation involves the actual delivery—usually to a point conveniently located by the storage box or refrigerated showcase. The method of delivery is determined by the quantities of products to be delivered. For small volumes, where two cases or less are required, the driver ordinarily carries the cases by hand. For larger deliveries, most wholesale milk delivery trucks carry a small, four-wheel dolly on which five or six cases can be piled and pushed directly into the customer’s premises. Where very

large volumes are delivered at a single outlet, a larger dolly, hand truck, or mechanical fork-lift truck may be made available by the store management. In some instances, a system of conveyors is utilized. After the products have been delivered, the driver makes the financial settlement. This may consist of either collecting cash or obtaining the signature of the store manager, or some other authorized person, on the sales slip. The driver then assembles empty containers, returns and loads them on the truck, and is ready to proceed to his next stop.

Each of the above-mentioned operations was timed separately. In addition, any time spent in waiting or talking while serving the customer was observed. The distance involved in making deliveries was recorded for each customer, and a notation was made of special services—such as arranging or putting the products away in the display space. Quantities of products delivered, by type and size of container, were recorded for each set of observations. Notation was also made of

the number of distributors who normally serviced each individual outlet. (See Appendix A, p. 68, for instructions and data forms given to the timers.)

Retail delivery observations. No effort was made to break down the individual retail delivery into its component parts. Here the gross time spent in directly serving each customer was noted—including all time, from the moment the truck was securely parked at the delivery location until the driver was ready to proceed to the next delivery point. In addition, however, any operation which was not normally a part of a routine delivery—such as time spent waiting or talking, time spent making collections, and any other nonrecurrent interruption—was timed in order that the frequency of these interruptions and their effect upon time requirements could be accounted for in the analysis. The number of customers served per delivery trip, the volume delivered per customer, and the walking distance required per delivery trip were also recorded.

Analysis of Time Requirements

During the course of a day's work, the route driver performs several quite different types of duties. Time requirements for these various tasks are related to different types of variables. For this reason, the total route time in this analysis was broken down into driving time, time spent in directly serving customers, and miscellaneous time.

Wholesale Route Driving Time

The amount of time spent in driving the delivery truck depends on the distance to be traveled and the rate of speed which can be maintained. The rate of speed, in turn, depends upon such factors as traffic and road conditions and the number of stops—either for traffic or to service customers—which are involved. It was not possible to include, in the analysis,

the influence of road and traffic conditions, however, as these are difficult to measure objectively. Nor was an attempt made to obtain information on the number of traffic stops or the corresponding time requirements. The results, therefore, represent average traffic conditions for the routes studied.

Presumably, average rates of driving speed would vary with the different conditions met in driving from plant to route, between customer stops while on the route, and from route to plant. For this reason, data were obtained on the distance traveled between these points and on the driving time required. In addition to the distance factor, the number of customer stops made by the driver was available, and was used in multiple

correlation analyses of the time spent in driving between the first and last customer stop. The results of these analyses are summarized in table 4.

Driving time was closely related to route distances as indicated by the fact that, in all instances, this single factor explained more than 65 per cent of the total variance in time requirements for this function. If the slight variations in rate of travel on the various subdivisions of the wholesale routes are ignored, and if the separate coefficients are combined on the basis of weighting by the appropriate average distances traveled, the following expression of total driving time requirements for wholesale routes is obtained.

$$Td = 27.54 + 1.11M + 0.28C \qquad (1)$$

where *Td* represents total route driving time in minutes, *M* the total daily miles, and *C* the number of customers served. Note that this expression of driving time results from an analysis of many routes operated under different conditions. For this reason, the regression coefficients—particularly that relating to distance traveled—should not be considered as representing the “marginal” speed of

wholesale milk trucks. Many of the differences in miles traveled occurred between routes operating in densely populated areas and those serving outlying areas separated by relatively sparse regions. Routes serving the former were over heavily trafficked city streets, while part of the latter driving was on high-speed highways. Thus, the 1.11 minutes per mile expressed above does not mean that wholesale milk trucks in California travel at a rate of 54 miles per hour!

Direct Wholesale Delivery Time Requirements

The operations under consideration in this section are those performed at the customer’s establishment, by the route driver in providing delivery services. Time observations for each set of services began when the truck arrived at the buyer’s premises, and ended when the driver re-entered the truck cab, ready to continue his route. Individual recordings were made of the amount of time spent in each of the following categories: (1) securing order; (2) putting up order; (3) delivering; (4) waiting; (5) talking; (6) securing signature or (7) securing cash; and (8) completing delivery. Provision was further made for any functions not specifically noted

Table 4. Effect of Distance Traveled and Number of Customers Served on Time Spent in Driving, Wholesale Milk Delivery Routes, All California Markets Combined

Area covered	Total distance	Time per day (fixed)	Time per mile	Time per customer	Corrected correlation coefficient
	per cent	minutes	minutes	minutes	
Plant to first stop.....	6.9	2.36	1.26	....	0.886
First to last stop.....	83.7	21.10	1.08	0.28	0.833
Last stop to plant.....	9.4	4.08	1.26	....	0.830
Total.....	100.0	27.54	1.11*	0.28	....

* Obtained by weighting the average mileage by the proportion of the mileage traveled in each phase of the total route coverage.

above so that the sum of the time spent on all functions or operations accounted for the total time spent at the customer's premises.

Each of the deliveries was classified into one of the following types: (1) grocery stores where delivery did not include placing or arranging products in display case; (2) grocery stores where the delivery did include display case services; (3) restaurants where the principal item of delivery (usually half pints of milk) was in paper containers; (4) restaurants where the principal item of delivery was in glass containers; (5) drugstore fountains and dairy bars; and (6) schools, institutions, and commissaries.

For these types of customer outlet, the data were broken down into relatively small groups according to the volume of delivery. Table 5 presents the cumulative frequency distributions of the percentages of customer numbers and of total volume for the classification of grocery stores where no special display case services were provided. While these data relate to the Los Angeles market only, they typify those found in all other California markets. Note that half of the customers received less than 50 labor units of milk products per delivery, but that these customers accounted for only 13 per cent of total volume. At the other extreme, less than 3 per cent of the customers received 500 or more labor units, and these large customers accounted for more than 30 per cent of total volume. (A labor unit refers to a system of weights, developed by the Bureau of Milk Control, by which the various products and container sizes handled on milk routes can be aggregated. In theory, each labor unit is equivalent, in terms of its labor requirement, to a quart of milk. These labor unit modifiers for the various items are given in Appendix B, tables B-1 and B-2, pp. 74 and 75.)

With the exception of the very small customers (receiving 24 labor units or less per delivery), most wholesale outlets received milk products from more than one distributor. The number of distributors serving each customer who made purchases from independent distributors, again for the Los Angeles market only, is shown in table 6.

This means, of course, that the average size of customer is considerably larger than the average volume per delivery and that the economies of large-volume deliveries are not currently being realized to full advantage.

On the basis of an intensive analysis of a relatively few of the total number of routes for which data were available, it was decided to use the single, independent variable of volume (measured

Table 5. Cumulative Frequency Distributions of Number of Customers and Volume, by Volume Groups, Groceries, and Markets,* Los Angeles, 1950

Volume per stop	Cumulative percentage of number of customers	Cumulative percentage of volume delivered
labor units		
0- 14.....	11.3	1.1
15- 24.....	25.0	3.7
25- 49.....	50.6	12.8
50- 74.....	66.7	22.3
75- 99.....	76.7	30.7
100-124.....	81.9	36.2
125-149.....	85.5	41.0
150-174.....	88.3	45.4
175-199.....	89.8	48.1
200-224.....	91.2	50.9
225-249.....	92.4	53.5
250-274.....	93.0	55.1
275-299.....	93.9	57.5
300-349.....	94.9	60.6
350-399.....	95.8	64.1
400-449.....	96.5	66.8
450-499.....	97.1	69.3
500 and over....	100.0	100.0

* Not including those receiving special display case services.

Table 6. Percentage of Distributors Delivering to Customers in Each Delivery Volume Group, Los Angeles, 1950

Size of stop	Per cent of total stops	Number of distributors per customer				
		1	2	3	4	5
labor units		per cent	per cent	per cent	per cent	per cent
0- 24.....	26.9	64.8	24.5	8.3	2.1	0.3
25- 48.....	26.0	43.2	40.9	13.2	2.2	0.5
49- 72.....	16.2	41.6	42.8	13.6	2.0	...
73- 96.....	10.0	41.0	41.0	14.3	3.7	...
97-192.....	13.7	41.0	38.0	18.2	2.5	0.3
193 and over.....	7.2	37.9	37.9	20.0	3.1	1.1

in terms of labor units) to explain variation in the amount of time spent in direct delivery. These trial analyses further brought out the fact that the functions were not linear and that the relatively simple curve types (such as second-degree parabolas) that could be fitted mathematically were inappropriate for the entire range of the data. These curve types are inappropriate in that they consistently overestimate time requirements in the low-volume ranges.

One of the great advantages of the use of regressions which have been fitted mathematically lies in the fact that interpretations can be made with respect to various companion statistics concerning the significance of the regression coefficients and the reliability of the regression itself. These measures (such as *t*-ratios and standard errors of estimate) are based on certain characteristics of the dispersion of normal distributions. While the frequency distributions of data to which these measures are applied are often not "normal," the error so introduced is overlooked in favor of the convenience and general acceptability of the method. A further condition for the application and usual interpretation of the standard error of estimate⁸ is that the

variances of the original observations be equal to all points along the regression. This is to say that the variance is not functionally related to the magnitude of the independent variable.

A test was made to determine whether the dispersions of the data being analyzed were homoscedastic. (Arrays in which the variances are equal are said to be homoscedastic; in the contrary case, heteroscedastic.) This investigation made it clear that the variances of the time requirements are not equal, but are an increasing function of the volume of milk and dairy products delivered. For this reason, and because none of the relatively simple curves appeared to be appropriate, it was concluded that use of the more orthodox forms of mathematical regression and correlation techniques could not be justified in the analysis of the present problem.

Rather, the decision was made to classify the data into relatively small groups according to the volume delivered. The time-volume relationships then could be determined on the basis of the means of these groups. The variance of the individual observations around these means could be calculated, and the differences between the variance of the groups could be considered in order to arrive at meaningful statements

⁸ The standard deviation of the residuals of the actual observations around the regression.

with respect to the significance and reliability of the basic relationship. Since the standard error of estimate is, in fact, the standard deviation of the residuals, these standard deviations can be determined for each group, thus providing a measure of the dispersion of observations comparable to the standard error of estimate but taking into consideration the inequality of variances in the data. Furthermore, estimates of the standard error by size groups can be made of the time-volume relationship. This will then provide a basis for describing the reliability of the relationship in terms of probability statements of expectations of

the range in which similar time-volume means (from other samples from the same universe) will fall. It is recognized that independent consideration of the several volume classes will somewhat overestimate the standard error range of the regression, but this appears to be the most appropriate method that could be devised.

Labor requirements for customers receiving full service. When the data were segregated into volume groups, the average time per stop was calculated for each of the operations performed in providing delivery services. The same calculations were carried out for each type of

Table 7. Average Direct Time Per Stop for Specified Delivery Operations, Groceries and Markets, Los Angeles, 1950

Volume per stop	Secure order	Put up order	Deliver*	Wait and talk	Collect	Complete delivery	Total full service
labor units	time in minutes per stop						
0- 14.....	1.28	0.72	0.50	0.14	0.77	0.53	3.94
15- 24.....	1.54	1.22	0.59	0.31	0.54	0.63	4.83
25- 49.....	1.85	1.73	0.70	0.36	0.73	0.78	6.15
50- 74.....	2.16	2.37	0.88	0.73	0.94	1.09	8.17
75- 99.....	2.32	3.06	1.00	0.72	1.61	1.24	9.95
100-124.....	2.70	3.55	1.51	0.70	1.57	1.46	11.49
125-149.....	3.34	4.49	1.85	0.80	2.00	1.70	14.18
150-174.....	3.02	4.48	2.19	1.46	2.10	1.96	15.21
175-199.....	4.06	5.60	2.63	0.72	1.68	2.15	16.84
200-224.....	3.19	5.36	2.07	0.61	2.05	2.34	15.62
225-249.....	3.80	5.25	2.76	0.65	2.14	2.86	17.46
250-274.....	4.38	6.15	3.95	4.68	2.08	2.94	24.18
275-299.....	4.86	6.93	3.65	0.23	2.81	2.09	20.57
300-349.....	5.24	7.84	4.35	2.38	2.80	3.52	26.13
350-399.....	4.66	6.99	4.51	0.40	2.88	3.63	23.07
400-449.....	5.21	8.60	5.22	1.38	2.49	2.89	25.79
450-499.....	5.82	8.17	4.46	0.38	2.47	2.97	14.27
500-599.....	5.03	10.99	4.59	2.41	3.52	4.62	31.16
600-699.....	3.73	10.76	7.61	1.39	3.57	3.95	31.01
700-799.....	5.42	9.68	7.44	0.33	4.84	5.88	33.59
800-899.....	7.10	11.06	10.51	2.39	4.39	5.73	41.18
900-999.....	5.15	13.60	5.60	0.43	4.12	2.37	31.27
1,000 and over†...	9.57	14.19	12.82	6.90	3.43	7.47	54.88

* Excluding stops where products were arranged or placed in display case. These display case services were provided in less than 20 per cent of all grocery stops in Los Angeles.

† Average volume per stop of "1,000 and over" approximately 1,800 labor units.

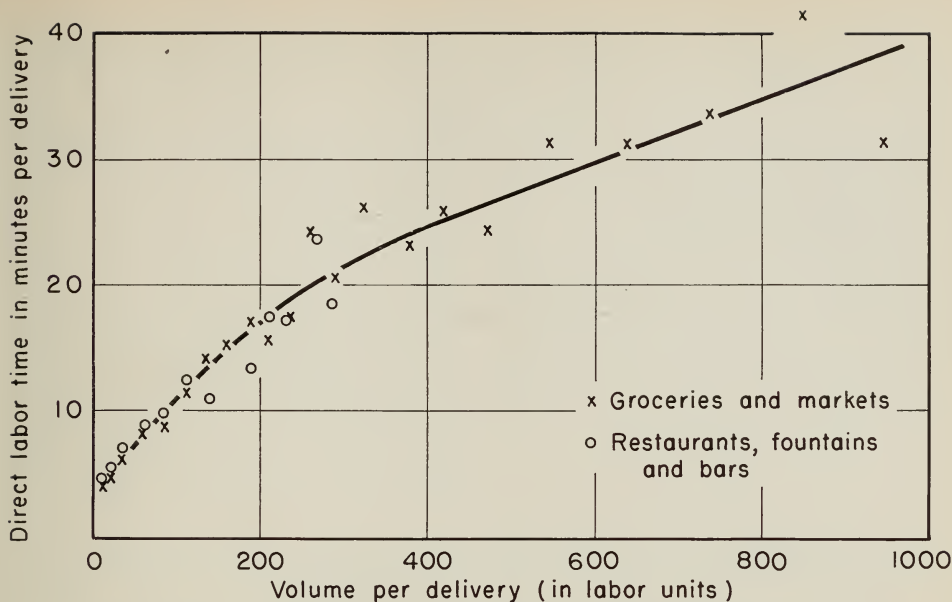


Fig. 1. Effect of volume per delivery on delivery labor—wholesale milk routes.

stop classification previously mentioned. These averages relating to deliveries to groceries and markets not receiving special display case services are presented in table 7. The way in which the total direct time requirements per stop increase with increases in volume per stop is indicated in figure 1 where the "total full service" column of the table is presented by x's. (The analysis of total direct delivery time has been made by summing the average time requirements for each operation in order to eliminate the influence of variation in the amounts of service provided by the driver.) Since no consistent differences could be found between similar sums of these averages calculated for the two restaurant classifications and fountains and bars, these groups were combined, with the results shown in figure 1 by o's. As shown by the curve drawn through them, these points follow a relatively uniform pattern. This curve, used to describe the time-volume relationship for wholesale milk deliveries to outlets of these types, smooths out the random variation in the

time observations present in the sampling distribution.

The same type of average time requirement calculations made for schools, institutions, and commissaries differs substantially from those for the grocery and restaurant classification shown in the figure. A comparison of the amount of time required to serve equivalent volumes to groceries and to the institutional type of outlet is shown in table 8. These differences exist in spite of the fact that allowances have already been made for differences in the types of product and container sizes delivered and for variations in the number of services provided.

Since the time-volume relationship in figure 1 was fitted graphically, the standard error of estimate was calculated from the deviations between actual and estimated values for individual observations.⁹ Correlation coefficients were then calculated from these standard errors of estimate and the standard deviations

$$^9 S_y = \sqrt{\frac{\sum d^2}{N}}$$

of the originals, and are presented in table 9.¹⁰ As noted before, however, the procedure used in calculating these statistics—based on independent consideration of the individual volume classes—will tend to overstate the standard errors and thus underestimate the correlation coefficient. While the figures do give some indication of the reliability of the relationships presented, they must, however, be interpreted somewhat loosely.

Similar analyses were made of wholesale time requirements for the six other

markets studied. With the exception of one component operation—that of “deliver”—results closely approximated those for the Los Angeles market. This reflects the fact that the basic operations for these component elements, such as “secure order,” “put up order,” “collect,” and others, were performed essentially in the same manner and to the same degree in all of the markets when routes were analyzed. Subsequent investigations to determine why time requirements for “deliver” differed in the Los Angeles market showed that the operation itself was essentially different. In all markets except Los Angeles, the route

$$^{10} r = \sqrt{1 - \frac{S_y^2}{\sigma_y^2}}$$

Table 8. Comparison of Average Direct Time Requirements for Full-Service Deliveries to Groceries, Markets, Schools, Institutions, and Commissaries, Los Angeles, 1950

Volume per stop	Direct time per stop: groceries and markets	Direct time per stop: schools, institutions, and commissaries
labor units	minutes	minutes
0- 14	3.94	4.69
15- 24	4.83	4.52
25- 49	6.15	5.33
50- 74	8.17	7.31
75- 99	9.95	8.84
100-124	11.49	6.16
125-149	14.18	8.02
150-174	15.21	8.05
175-199	16.84	9.98
200-224	15.62	6.58
225-249	17.46	15.42
250-274	24.18	12.15
275-299	20.57	20.78
300-349	26.13	.....
350-399	23.07	7.66
400-449	25.79	15.05
450-499	24.27	11.13
500-599	31.16	27.66
600-699	31.01	16.68
700-799	33.59	.....
800-899	41.18	28.17
900-999	31.27	.....
1,000 and over	54.38	13.53

Table 9. Correlation Between Direct Time per Delivery and Volume per Delivery for Specified Types of Wholesale Outlets, Los Angeles, 1950

Type of outlet	Uncorrected correlation coefficient*	Proportion of variance in time which can be explained in terms of volume delivered
		per cent
Groceries without display case services	0.864	75
Groceries with display case services	0.885	78
Restaurants receiving products in paper	0.650	42
Restaurants receiving products in glass	0.504	25
Fountains and bars	0.661	44
Total of all observations	0.869	76

* Correction factors were not applied because of the indeterminacy of the number of degrees of freedom present in a function of this type. The number of observations was sufficiently large, however, so that the amount of correction required will be quite small.

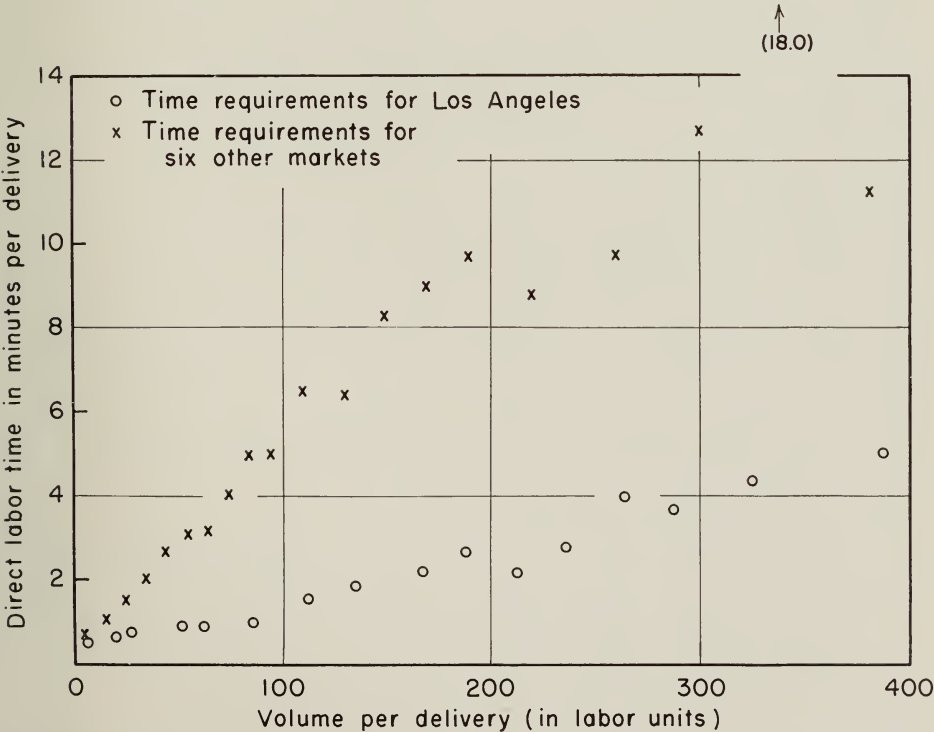


Fig. 2. Comparison of time for "Deliver" element, Los Angeles, San Francisco, Contra Costa, Sacramento, Stockton, Fresno, and San Diego markets—wholesale milk routes.

driver is expected to place the day's deliveries in the refrigerated display case, while in Los Angeles no such services are normally provided. The differences in the time requirements for the single function of "deliver" are shown in figure 2.

The average direct delivery time requirements for full service operations for the six markets other than Los Angeles are shown in table 10. A "full service operation" is defined as a delivery in which all of the individual elements are performed. This includes "secure order," "put up order," "deliver," "collect," and "complete delivery." In other words, if the driver knew the order in advance and, therefore, was not required to perform the "secure order" element, it would not be considered as a "full service" delivery, and the observation would be eliminated from this part of the analysis. The averages are presented, by volume classes, for each market as well as for all markets combined. In addition, for each market group there is a column headed "standard deviations." It should be noted that these are not standard deviations around the individual means in the usual sense. Rather, the statistics have been calculated from the individual observations in each group. They are based on the sum of squared residuals of *actual* time from *estimates* of time which were derived from a relationship (smoothed by freehand methods, to the means of all markets combined). In general, this table illustrates that the variances of the groups increase with increases in size of volume classification. On the other hand, there do not seem to be significant differences between markets as judged by the group-by-group magnitude of these standard deviations. No one market shows a definite pattern of consistently larger or smaller standard deviations than the others. Since such bias was not observed, it was taken as partial justification for combining data from the different markets.

The fact that no significant differences were found among time requirements in these different geographical markets is not surprising. Since individual operations or elements of delivery are the same, regardless of the market in which they occur, the time requirements might be expected to be similar. In other words, if a route driver has to go through a series of physical operations to make a delivery, it makes no difference whether he does so in San Francisco or in Fresno. On the basis of this reasoning, the results of these studies should be applicable to areas other than California, provided the basic elements or components of delivery operations are similar.

Figure 3 shows the effect of the added time requirements—display case services commonly provided by the wholesale milk driver in California markets other than Los Angeles. Here the smooth relationship previously presented in figure 1, representing the total "full service" time requirements for the Los Angeles market, is reproduced and compared with a relationship similarly constructed which portrays the "full service," time-volume relationship for the six other markets. Since the difference between these two relationships reflects primarily the different degrees of service rendered (the delivery operation in the six markets includes filling and arranging the display case, whereas in Los Angeles it does not), these different relationships are labeled "delivery with display case service" and "delivery without display case service," respectively, in the diagram.

Labor requirements for customers receiving less than full service. Up to this point, the discussion of labor requirements has been appropriate for deliveries in which the driver performs the full set of services—that is, secure order, put up order, deliver, wait and talk, collect, and complete delivery. In many instances, not all of these oper-

Table 10. Average Direct Time Requirements and Standard Deviations,* Wholesale Milk Deliveries, Groceries, Restaurants, and Fountains, Six California Markets, Full Service Operations

Volume Classifica- tion	San Francisco		Alameda-Contra Costa		Fresno		Stockton		Sacramento		San Diego		All markets	
	Average time	Standard deviation	Average time	Standard deviation	Average time	Standard deviation	Average time	Standard deviation	Average time	Standard deviation	Average time	Standard deviation	Average time	Standard deviation
labor units	minutes per stop													
0- 9	3.3	1.6	3.4	1.3	3.5	1.7	3.6	1.4	3.9	1.7	5.2	2.4	3.5	1.6
10- 19	4.3	1.6	4.2	1.6	4.6	1.6	5.2	1.9	5.6	2.1	5.6	2.3	4.8	1.7
20- 29	5.6	2.4	5.7	2.0	6.0	2.2	6.3	2.7	6.3	2.3	7.1	2.5	6.0	2.3
30- 39	7.1	2.5	6.7	2.3	7.3	2.5	7.8	3.0	7.5	2.7	8.3	2.9	7.5	2.6
40- 49	7.7	2.7	8.2	2.5	8.6	3.1	9.2	3.2	9.1	2.8	8.6	3.0	8.8	2.9
50- 59	8.8	3.5	9.5	3.1	9.5	3.2	9.7	3.5	10.5	2.9	9.7	1.6	9.8	3.3
60- 69	9.2	3.5	10.8	3.8	9.6	2.6	11.1	4.7	10.4	4.0	11.7	2.4	10.4	3.6
70- 79	10.1	3.7	11.4	2.9	11.9	3.8	10.5	4.2	13.0	4.0	11.7	3.7	11.6	3.8
80- 89	12.2	4.8	13.9	3.8	13.3	4.8	12.8	8.7	12.1	3.0	13.6	5.4	13.1	4.0
90- 99	12.7	4.1	11.9	4.1	10.6	3.3	14.6	4.4	12.5	2.8	12.9†	1.8	13.2	3.9
100-119	13.5	6.3	15.8	5.5	15.3	4.2	16.2	4.6	16.0	4.8	10.2†	4.6	15.6	5.1
120-139	13.1	4.8	16.1	3.8	15.6	4.0	16.9	5.2	15.0	2.7	15.3†	4.4	15.6	4.3
140-159	9.1†	8.3	17.0	4.8	15.0	4.9	17.4	4.8	17.4	4.4	14.4†	1.9	15.8	5.2
160-179	16.8	7.1	18.1	5.3	17.0	2.6	19.3†	1.1	22.8	5.9	16.3†	2.8	21.0	5.3
180-199	24.6†	4.1	16.0†	6.2	22.2	7.0	16.2†	6.2	....	....	20.6†	0.4	20.9	6.2
200-239	....	....	25.7†	9.1	19.4†	3.1	29.8†	10.7	18.4†	6.3	21.1†	7.7	20.8	7.9
240-279	20.0	8.3	27.9†	2.2	24.5†	2.5	34.8†	10.2	32.3†	8.1	....	....	22.2	7.1
280-319	14.5†	14.1	27.3	2.2	22.9†	4.3	33.3†	6.3	26.3†	7.4	20.4†	9.1	28.7	8.0
320-359	16.3†	15.0	27.0†	3.7	27.6†	5.4	....	....	31.1†	14.4	....	....	22.4	11.3
360-399	19.6†	14.3	28.9†	4.9	....	....	40.7†	7.6	....	....	....	....	25.3	11.1
400 and over	33.0†	7.9	44.0†	4.5	8.4†	43.1	....	....	32.2†	19.8	45.9†	9.7	38.6	22.6

* Standard deviation = $\sqrt{\frac{\sum d^2}{N}}$ where d represents residual of actual observations from estimate based on smoothed average relationship developed from data in all markets combined.
† Indicates averages based on fewer than five observations.

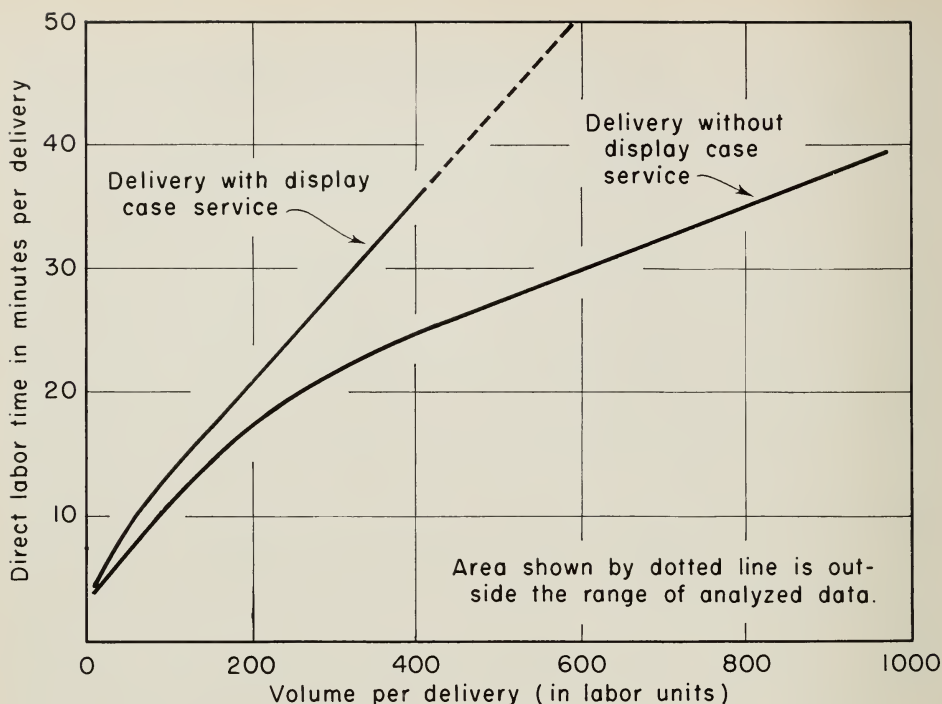


Fig. 3. Effect of volume per delivery on direct delivery labor with and without display case service—wholesale milk routes.

ations are carried out. For example, the daily requirements for some customers are known by the driver prior to his arrival, and the operation, "secure order," is eliminated. Furthermore, various forms of streamlining the set of operations performed by the driver may exist. Depending upon the nature of the company policy in these cases, therefore, only certain combinations of operations and their respective time requirements are appropriate for specific types of deliveries.

It will be recalled that the time-volume relationship discussed under direct time requirements was based on the summation of the averages in columns 1 through 6 in table 7. The average time requirements for each operation were calculated on the basis of only those stops where the operation was, in fact, performed. (This statement is not true for the averages included as "wait and talk." These figures represent the average amount of

time spent in this manner for all stops, including those where no waiting or talking was done. This procedure seems justified by the chance or random nature of these time categories.) It was possible to determine the time requirements for stops receiving less than full service by including in the total only the amounts of time required to perform those operations which were actually carried out.

Two types of streamlined services appear to be particularly interesting: (1) that in which "secure order" and "collection" are eliminated; and (2) that in which, in addition to the above, the operation of "delivery" is eliminated by placing the products on the sidewalk or platform. The first of these involves a set of operations similar to the services normally performed in a *retail* delivery operation where the order typically is known in advance and collection is made on a weekly or monthly basis. The second is applicable to a set of minimum

services characterized by sidewalk delivery. The total time requirements for stops with these differential types of services are shown in table 11 where service type "A" refers to the full set of services discussed in previous sections; type "B" refers to stops where the order is known in advance and collection is made other than by the route driver; and type "C" is appropriate for a minimum set of operations with sidewalk delivery.

Smoothed regressions have been determined for time requirements based on these types of service differentiation and appear with the time-volume relationship

for full-service stops in figure 4. The savings in direct delivery time that can be made with these streamlining operations can be readily seen. In the same amount of time, a driver can make a delivery of 90 labor units under type "A," approximately 165 labor units with type "B," and over 250 labor units when type "C" services are performed.

Reliability of the time-volume relationship. As indicated earlier, the variances associated with the average time requirements are not constant but tend to increase with increases in the volume delivered. The standard errors of

Table 11. Comparison of Time Requirements for Alternative Types of Delivery Services

Volume per stop	Type of service*		
	"A"	"B"	"C"
labor units	minutes	minutes	minutes
0- 14.....	3.94	1.89	1.39
15- 24.....	4.83	2.75	2.16
25- 49.....	6.15	3.57	2.87
50- 74.....	8.17	5.07	4.19
75- 99.....	9.95	6.02	5.02
100-124.....	11.49	7.22	5.71
125-149.....	14.18	8.84	6.99
150-174.....	15.21	10.09	7.90
175-199.....	16.84	11.10	8.47
200-224.....	15.62	10.38	8.31
225-249.....	17.46	11.52	8.76
250-274.....	24.18	17.72	13.77
275-299.....	20.57	12.90	9.25
300-349.....	26.13	18.09	13.74
350-399.....	23.07	15.53	11.02
400-449.....	25.79	18.09	12.87
450-499.....	14.27	15.98	11.52
500-599.....	31.16	22.61	18.02
600-699.....	31.01	23.71	16.10
700-799.....	33.59	23.33	15.89
800-899.....	41.18	29.69	19.18
900-999.....	31.27	22.00	16.40
1,000 and over.....	54.38	41.38	28.56

* Service type "A" includes secure order, put up order, deliver, waiting and talking, collecting, and completing delivery. Service type "B" excludes secure order and collect from above. Service type "C" involves sidewalk delivery and eliminates the delivery time included in type "B." In all cases, these figures are based on deliveries which do not include display case services.

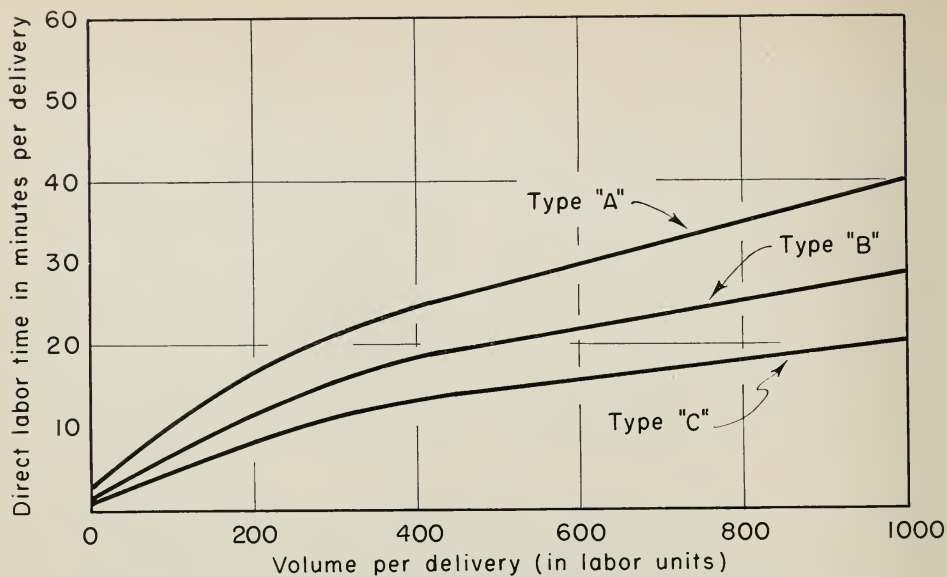


Fig. 4. Effect of volume per delivery on direct delivery labor time with alternative amounts of service performed—wholesale milk routes.

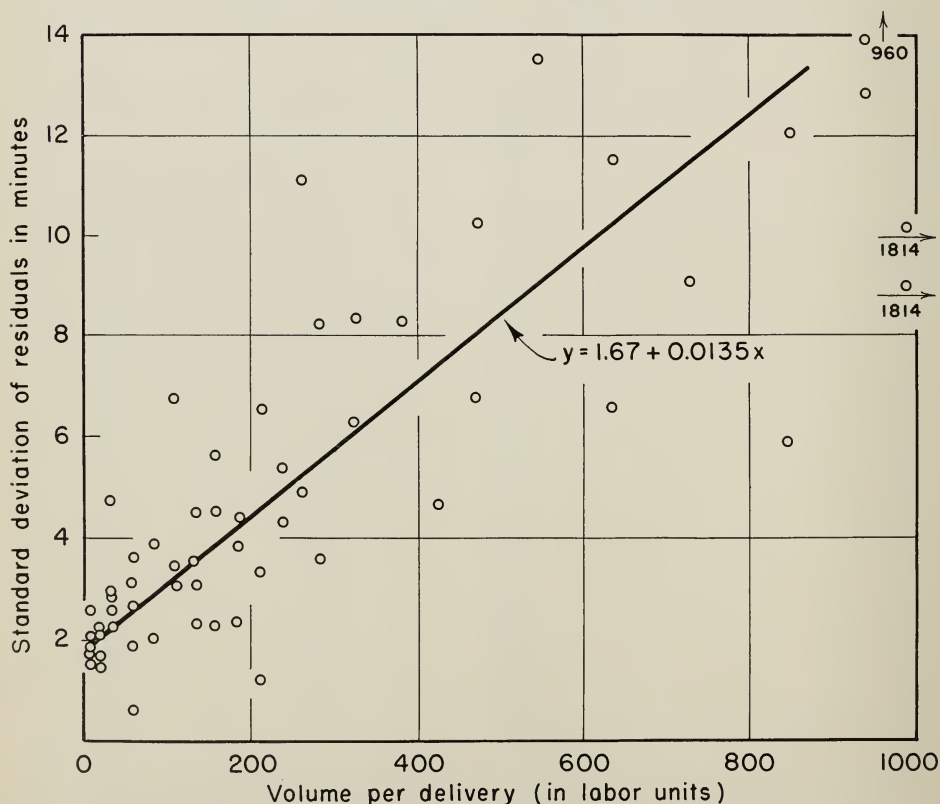


Fig. 5. Standard deviations of residuals of actual values from estimated values—wholesale milk routes, Los Angeles, 1950.

estimate for the various size and stop classifications for full-service deliveries are presented in figure 5. A smooth relationship, passing through the average of the standard deviations of residuals,¹¹ was fitted by freehand methods to these observations and is represented on the diagram. This linear function was then applied to the smoothed time-volume relationship (shown in fig. 1) to determine a band around the regression as shown in figure 6. This band, which represents one standard deviation of residuals above and below the regression, includes approximately two thirds of the individual observations of the sample. It can be seen that the dispersion of the individual time observations around the mean relationship is considerably greater for large-volume than for small-volume customers. It should be noted, however, that the distribution of time observations for any

volume group tends to be somewhat skewed, with the modal time displaced toward the lower end of the distribution. This means that, on the average, the distance between the lower limit to the band and the regression will include somewhat more than one third of the cases, and conversely, that the distance between the regression and one standard deviation of residuals above the regression at any point will contain slightly less than one third of the observations.

The linear relationship of the standard deviations of residuals has also been utilized to determine the smoothed approximation to the standard error of the regression. By dividing the value of the standard deviations of residuals (as indicated by this relationship) by the square root of the number of observations found in the sample for each volume group, estimates of these standard errors were obtained. These appear in figure 7 where irregularities have been smoothed out by a continuous curve to eliminate the effects of chance variations in the volume frequency distribution.

¹¹ Note that these are the standard errors of estimate but that the above term will be used in the discussion in order to reduce confusion in terminology.

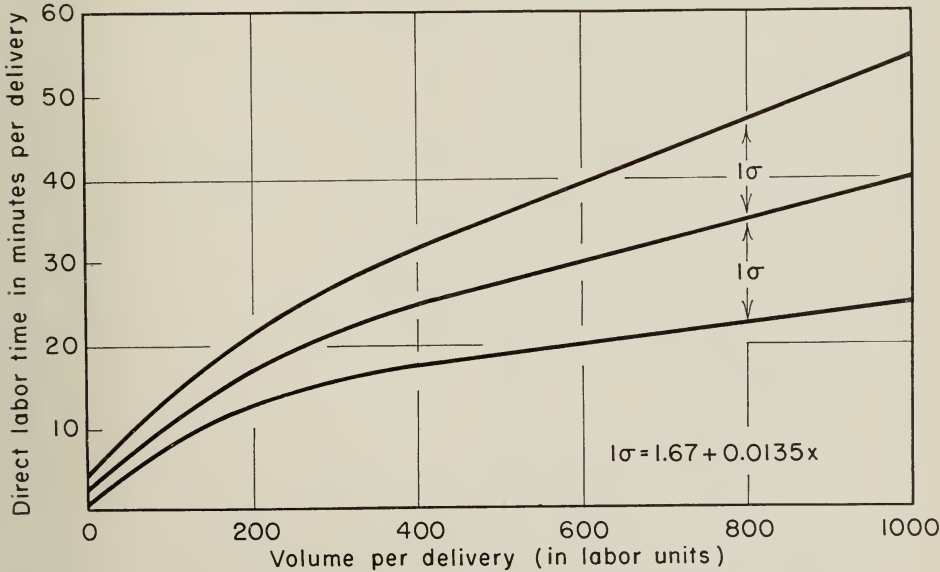


Fig. 6. The range (including approximately two thirds of the observations) as indicated by the range of one standard deviation of residuals, delivery without display case service—wholesale milk routes.

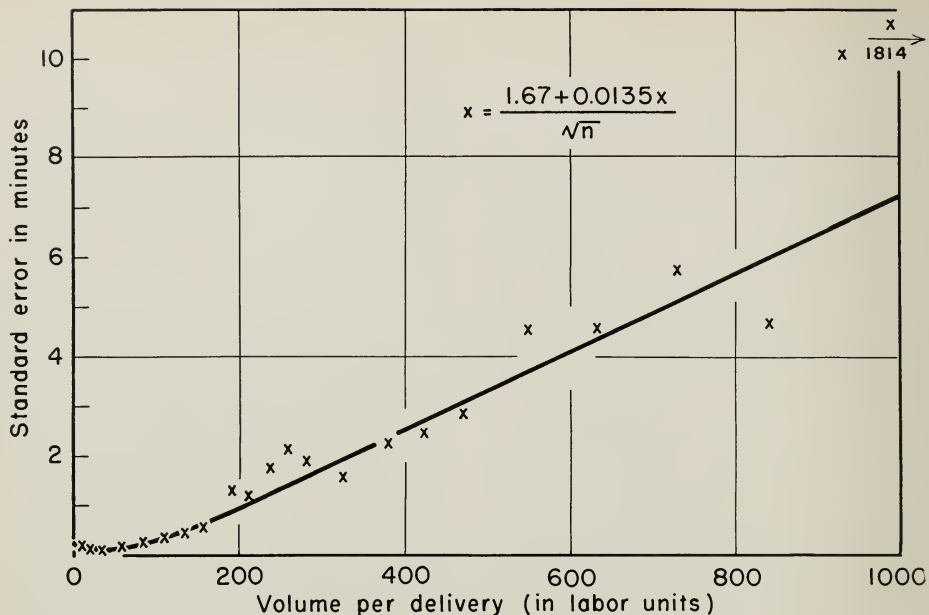


Fig. 7. Standard errors of the time-volume regression, delivery without display case service—wholesale milk routes.

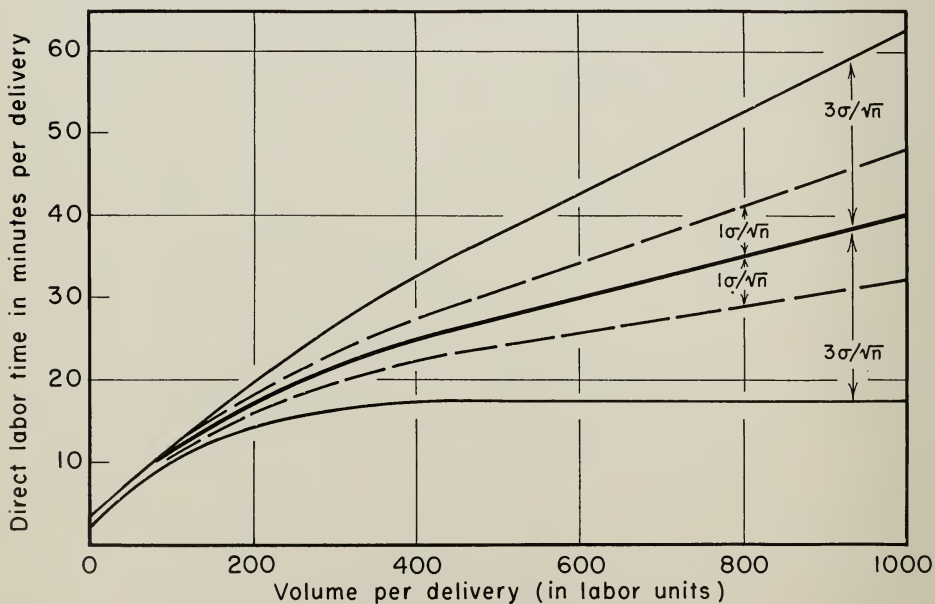


Fig. 8. Reliability of the time-volume regression as indicated by ranges of one and three standard errors, delivery without display case service—wholesale milk routes.

These ranges have been plotted in relation to the time-volume relationship in the manner described for the standard deviations of residuals previously discussed, and appear in figure 8. Ranges representing both one and three standard errors above and below the mean are presented. Note that, except for the process of smoothing in a continuous relationship, the method of treating the variance of each of these volume groups independently—rather than pooling the variance between groups as in conventional mathematical correlation techniques—tends to overstate the magnitude of this band and, consequently, understates the degree of reliability of the time-volume regression.

Applying the accepted interpretation of measures of this type, this means that, if successive samples were drawn from the same universe, and similar error bands were computed, comprising one standard error above and below the regression, the chances are that two out of three such bands would embrace the true regression of the universe. In less precise but generally understandable terms, it

¹² While the decreased number of cases in the large-volume ranges is a fairly serious limitation, a similar problem is present in every statistical analysis. Since the frequency distribution "tails off" at both ends, relatively few cases involving either extreme are recorded, which means that regressions are less reliable for very large and very small values of the independent variable than for the range between these extremes.

(For a further discussion of the nature of the reliability of the regression, see Ezekiel, M., *Methods of Correlation Analysis*, 2d ed.; New York: John Wiley and Sons, 1945. Chapter 18.)

¹³ The decreased importance is due to the fact that, although the original distribution may be badly skewed, the sampling distribution of means taken from that population is only slightly skewed since $\sigma_{\alpha_3} = \sqrt{6/N}$, the estimate of skewness for the sampling distribution, can depart very little from the normal value of zero with reasonably large values for N .

may be inferred that the chances are two out of three that the true regression lies within the distance included by one standard error above and below the regression from the sample, and that the chances are 997 out of 1,000 that the true regression lies within the range covered by three standard errors above and below the sample regression.

These "standard error bands" serve to indicate that regressions based on other samples drawn from the same universe will closely approximate the regression determined from this sample for delivery sizes in the low-volume ranges, but that this regression becomes increasingly unreliable in the larger volume ranges. This is partially a result of the increased dispersion of individual observations for the larger size stops and, in part, due to the greatly diminishing number of observations in each size group as the volume per group increases.¹² Furthermore, the limitation arising from the skewness of the data mentioned in the discussion of the standard errors of estimate is applicable to these measures, although to a much less important degree.¹³

Based on the limitations of alternative analytical approaches and on the reasonably satisfactory results as evidenced by the measures of goodness of fit and of reliability cited in previous pages, the time-volume regression in figure 1 is presented as a description of direct delivery time requirements under conditions where display case services are not provided by the driver. Although this regression was fitted graphically rather than by the use of mathematical techniques, the curve which was drawn to the data can be described (but not fitted) in mathematical terms. For delivery volumes of less than 377 labor units, the following second-degree parabola follows the regression:

$$T_s = 3.33 + 0.08556V_s - 0.0000806V_s^2 \quad (2)$$

For delivery volumes of larger than 377 labor units, the graphic function is linear, corresponding to the equation:

$$T_s = 14.76 + 0.024875V_s \quad (3)$$

These two equations have been so developed that they "smooth" together so that equation (3) is a straight line which is tangent to (2) at 377 labor units.

In markets such as the six California cities in which display case services are performed, the smoothed freehand relationship can be described as follows: For deliveries of 100 labor units or less:

$$T_s = 2.60 + 0.16125V_s - 0.000533V_s^2 \quad (4)$$

For deliveries of more than 100 labor units:

$$T_s = 6.04 + 0.073550V_s \quad (5)$$

In these equations, T_s represents the direct delivery time in minutes per customer, and V_s the volume of milk products (measured in labor units) delivered.

Miscellaneous Time

In addition to the time he spends driving and directly serving customers, the wholesale milk deliveryman also performs several other operations. Among these are: checking the load against daily requirements before leaving the plant, arranging the load and attending to personal needs while on the route, and checking in and making a settlement with the plant cashier on return to the plant.

Efforts were made to determine relationships between volume per route and/or the number of customers served, and the time spent in these operations. Separate analyses were made for each operation, and the operations were also lumped

together to see if the individual driver's habits might have a compensating effect. For example, one driver might take time out for coffee while on the route and another might wait until his return to the plant and go to the company lunchroom or beverage dispenser for refreshment. Meaningful results were not obtained in any of these analyses. There was some indication that drivers with routes requiring greater than average amounts of driving and direct delivery time used less than the average amount of miscellaneous time, and vice versa. This might result from the fact that, in these California markets, the union wage contract is based on an eight-hour day. As a consequence, there would be a tendency for the route man to spend almost exactly that amount of time on the job. It is very doubtful, however, that the differences observed in the average times spent in miscellaneous operations are statistically significant.

In view of the fact that no significant influence of route volume and number of customers on the amount of time spent in these miscellaneous operations could be found, the average for the sample routes has been used. For the 270 routes upon which adequate data were available, the mean time spent on all operations other than driving and direct delivery, but exclusive of lunch time, amounted to 69.2 minutes, the bulk of which was spent arranging loads and at the plant.

Total Wholesale Route Time

Driving time, direct delivery time, and time spent in miscellaneous operations have each been analyzed, and the relationships, if any, between the time requirements for these elements and the major time-affecting variables have been determined. These relationships have then been expressed in the form of the

Table 12. Summary of Time Requirements for Wholesale Milk Delivery Routes

Elements	Fixed minutes per day	Minutes per customer		Minutes per mile
		Fixed	Variable	
Driving	27.54	0.28		1.11
Direct delivery:				
Under 377 labor units		3.33	$0.08556V_{s_i} - 0.0000806V_{s_i}^2$	
Over 377 labor units		14.76	$0.024875V_{s_i}$	
Miscellaneous	69.2			
Totals:				
Under 377 labor units	96.74	3.61	$0.08556V_{s_i} - 0.0000806V_{s_i}^2$	1.11
Over 377 labor units	96.74	15.04	$0.024875V_{s_i}$	1.11

estimating equations summarized in table 12. In this table, the choice was made arbitrarily to use the Los Angeles—or “without display case service”—type of delivery. The other service type—or “with display case service”—could have been used equally well. (No effort is made to develop all of the necessary relationships from which final cost figures could be determined for more than this single type of service. The necessary data by which the subsequent procedures can be applied in order to make such analyses are available to the interested reader, in this report.)

As suggested in the table, these components can be combined to express total route time requirements as functions of the number of customers, the volume per delivery, and the number of miles covered by the route. Two equations are required, the first applicable for stops of less than 377 labor units and the second appropriate for the larger volume deliveries:

where C represents the number of customer deliveries, V_{s_i} the volume per stop at any given stop, D the daily route mileage, and T the daily total route time requirements in minutes. Note that the direct delivery time would be the aggregate spent at all stops on the route.

The equations can be simplified to express the total delivery time for all stops in terms of the average size of delivery on the route but with a minor loss in accuracy of statement for those routes serving customers who receive less than 377 labor units. Although the average volume per stop per route is stated as the ratio of total route volume to the number of customers served, the direct time requirements per delivery increase at a decreasing rate in the larger volume ranges. With wide variations in the size of deliveries on any given route, the time requirements calculated on the basis of the average size of stop and number of customers will be somewhat less than the

$$T = 96.74 + 3.61C + \sum_{i=1}^C (0.08556V_{s_i} - 0.0000806V_{s_i}^2) + 1.11D \quad (6)$$

$$T = 96.74 + 15.04C + \sum_{i=1}^C (0.024875V_{s_i}) + 1.11D \quad (7)$$

aggregate direct time spent making each delivery, although the amount of error introduced by this procedure will not be great. For example, estimates of the combined time for a stop of 50 units and a stop of 950 units are underestimated by 8 minutes (out of a total of 54 minutes) when calculated on the basis of two 500-quart stops. On the other hand, the same estimate is obtained when the total time for a 25-unit and a 125-unit stop is computed separately or when it is obtained by calculations based on two 75-unit stops.

Ignoring this discrepancy and expressing total time in terms of the average size of stop per route, we obtain:

$$T = 96.74 + 3.61C + (0.08556\bar{V}_s - 0.0000806\bar{V}_s^2)C + 1.11D \quad (6a)$$

$$T = 96.74 + 15.04C + (0.024875\bar{V}_s)C + 1.11D \quad (7a)$$

where $\bar{V}_s$ refers to the average size of stop on a given route.

Applying the relationships $\bar{V}_s C = V_r$ —the total route volume—and $C = V_r / \bar{V}_s$ these two equations may be expressed in the alternative forms given below in order to show the net influence of route volume:

$$T = 96.74 + 3.61 \frac{V_r}{\bar{V}_s} + 0.08556 V_r - 0.0000806 \bar{V}_s V_r + 1.11D \quad (6b)$$

$$T = 96.74 + 15.04 \frac{V_r}{\bar{V}_s} + 0.024875 V_r + 1.11D \quad (7b)$$

Retail Route Driving Time

Data were obtained, and analyzed, on the subdivisions of retail routes to permit separate determination of the influence of related factors in traveling from plant to route, from first to last stop, and from route to plant. In this case, however, a multiple-correlation analysis based on total route miles and number of customers served provided a "better fit" (in relation to that determined from separate analyses of the separate components) than it did in the wholesale route analysis, in terms of the size of the corrected correlation coefficient, and has therefore been used for this purpose. Table 13 shows the results of this analysis for the two markets in which retail routes were studied.

Again, the close association between driving time and route distance is noted, while the influence of distance and number of customers served, combined, explains approximately two thirds of the variance in driving time. If the regression coefficients for both the Los Angeles and Fresno markets are combined according to weights established by the number of routes studied in each market, the following expression of total route driving time is obtained:

$$T_d = 19.63 + 2.37M + 0.31C \quad (8)$$

where T_d represents total route driving time in minutes, M the total daily miles, and C the number of customers served. By combining the regressions determined for these two markets, the relatively large amount of "fixed" driving time in the Los Angeles study (20 minutes per day) is offset by the lower amount indicated for the Fresno area. On the other hand, the larger time requirements associated with the number of customers served in Fresno is balanced off by the smaller coefficient for this factor in Los Angeles. Also, the higher rate of driving speed

Table 13. Effect of Distance Traveled and Number of Customers Served on Time Spent in Driving, Retail Milk Delivery Routes, Los Angeles and Fresno, 1954

Market	Time per day (fixed)	Time per mile	Time per customer	Corrected correlation coefficient
	minutes	minutes	minutes	
Los Angeles.....	20.19	2.49	0.29	0.816
Fresno.....	16.43	1.72	0.43	0.880
Combined*.....	19.63	2.37	0.31	....

* Combined by weighting the individual regression coefficients by the number of routes included for each market.

determined in Fresno serves to reduce the magnitude of this coefficient in the "combined" equation.

Direct Retail Delivery Time Requirements

Methods of analysis. The operations in this phase of the analysis included the total time spent by the retail route man in making each delivery trip from the truck to the delivery point and return. A notation was made of the gross time spent on each delivery trip. In addition, each interruption encountered by the driver that was a departure from a routine delivery, such as waiting for or talking to the customer, or making collections, was timed. The time spent on these nonrecurring elements was then deducted from the gross time to determine a "net delivery time" which would be consistent among all observations. The frequency of and time spent on such interruptions were analyzed separately. (See Appendix A, p. 68, for instructions and data forms given to the timers.)

For each market, each observation was classified within relatively small groups according to the double classification of volume (measured in labor units) and delivery distance (measured as the round-trip distance between the truck and point of delivery). (One hundred

groups were used, with 10 volume classifications and 10 distance categories involved.) The average volume per stop, average distance per delivery, and average time requirements per stop were then calculated for each group. These averages were then weighted by the number of individual observations within the group, and subjected to a multiple-linear regression analysis.¹⁴ Figure 9 shows the net relation between volume per stop and direct time requirements for routine deliveries, in the Los Angeles market, when the influence of variations in delivery distance is eliminated. On this figure, also, are dots which represent the group averages previously discussed, adjusted for differences in mean distances.

Although some differences exist in the direct delivery time requirements for retail milk delivery in Los Angeles and Fresno, in the following discussion these two sets of analyses are combined and

¹⁴ This procedure was used in lieu of the more conventional method of applying the mathematical technique directly to the individual observations because of the substantial amount of clerical work involved in the latter method with approximately 18,000 observations. The abbreviated procedure will result in the same regression coefficients, although correlation coefficients computed from these averages will grossly overstate the closeness of fit, due to the fact that the averages themselves eliminate a substantial part of the variance.

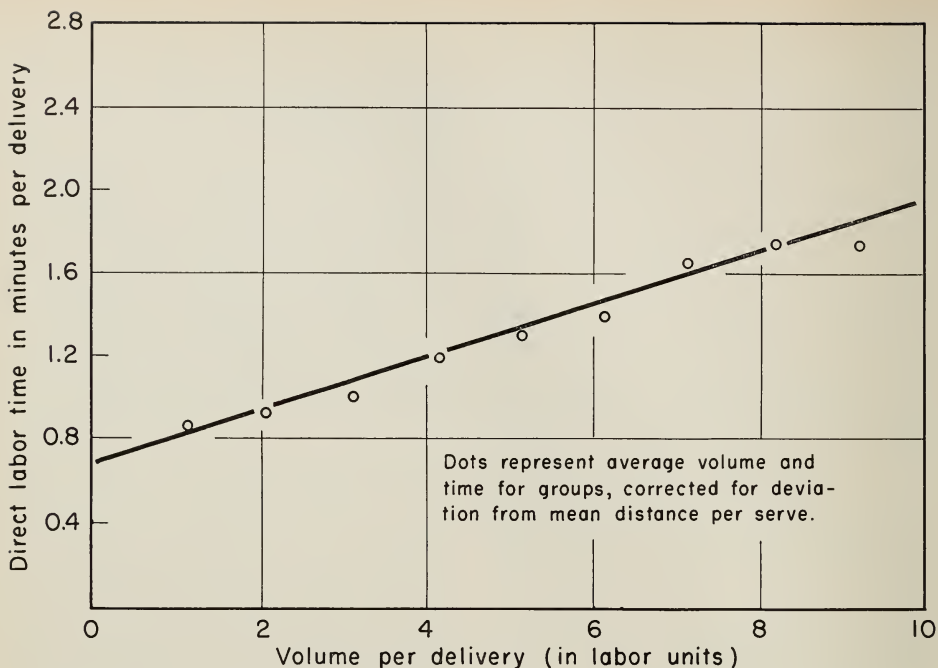


Fig. 9. Effect of volume per delivery on direct delivery labor time, retail milk routes, Los Angeles and Fresno markets combined.

a single set of results is presented. The relationship presented in figure 9 reflects only the time involved when a single-service, routine delivery trip is involved. Several adjustments must be made to account for extra trips for additional products wanted by the customer, the variations required by the fact that more than one customer may be served on a single delivery trip, time required for collections—whether daily, weekly, or monthly—and for time spent, on deliveries, in waiting for and talking to customers. Making these adjustments on the basis of average frequency and average time requirements, the total direct retail delivery time can be expressed:

$$T_s = .341 + .1178V_s + .0051F \quad (9)$$

where T_s represents direct retail delivery time in minutes, V_s the volume per delivery, and F the round-trip delivery distance in feet.

Miscellaneous Time on Retail Routes

This category includes the time spent on the route other than in driving and performing the direct operations of delivery to retail customers. In the aggregate, this amounted to an average of 80 minutes per day, exclusive of time spent at lunch. Of this, 59 minutes were spent at the plant in various operations before and after route deliveries were made; 14.8 minutes were spent in arranging the load while on the route—such as shifting cases of empty bottles; and 6.2 minutes were spent in personal affairs—such as taking a coffee break or a smoke. In the analysis, the personal and arrange-load times were treated as constant on a daily basis, while the time spent at the plant was treated as directly related to the number of customers since the major part of this time consisted of

bookkeeping activities which are more logically related to the number of accounts served.

Total Retail Route Time

The individual components of retail route time can be aggregated in the same manner as wholesale route requirements were summarized. Each of these separate components has been analyzed, and the relationships so determined are expressed in table 14.

These components may then be combined to express total route time requirements as functions of the number of customers, the volume per delivery, the distance from truck to delivery point and return, and the mileage covered by the routes. When this is done, the following expression is obtained:

$$T = 40.66 + 0.7706C + \sum_{i=1}^c (0.1178V_s + 0.0051F) + 2.37D \tag{10}$$

where T represents the total daily route

time requirements in minutes, C the number of customers served, V_s the volume per delivery, F the round-trip distance (in feet) from truck to delivery point, and D the daily miles covered by the route. Again, this equation can be simplified in terms of the average size of delivery on the route. In expressing total time in this way, we obtain:

$$T = 40.66 + 0.7706C + (0.1178\bar{V}_s + 0.0051\bar{F})C + 2.37D \tag{10a}$$

Applying the relationship $\bar{V}_sC = V_r$ —the route volume—this equation may be expressed in the alternative form below in order to show the net influence of route volume:

$$T = 40.66 + 0.7706C + 0.1178V_r + 0.0051\bar{F}C + 2.37D \tag{10b}$$

where the compound expression $\bar{F}C$ refers, of course, to the total delivery distance traveled by the routeman.

Table 14. Summary of Time Requirements for Retail Milk Delivery Routes, Los Angeles and Fresno, 1954					
Element	Fixed minutes per day	Minutes per customer			Minutes per mile
		Fixed	Variable		
			per unit	per foot	
Driving.....	19.63	0.310	.....	.....	2.37
Direct delivery.....	.....	0.341	0.1178	0.0051	....
Personal time.....	6.23	.....	.....	.....	....
Arrange load.....	14.80	.....	.....	.....	....
At plant.....	.....	0.1196	.....	.....	....
Total.....	40.66	0.7706	0.1178	0.0051	2.37

Cost-Volume Relationships in Wholesale Milk Delivery

The preceding section has developed basic functions relating route requirements to such factors as total route volume, number of customers, route miles, and volume per customer. While these equations may be applied to many types of problems in milk distribution, and thus may be considered valuable ends in themselves, the main objective of this study, and of the present section in particular, is to apply the equations to the problem of the effects of scale of delivery on distribution costs. This will require four major steps: (1) conversion of the basic time equations to ones that show the appropriate effects of volume per stop on time per stop; (2) conversion of the labor requirement function to a cost equation by the application of suitable wage and labor cost rates; (3) addition of other delivery costs; and (4) summation of these into functions showing the effects of volume per customer on delivery costs per customer and per unit delivered.

Effect of Volume per Stop on Route Volume and Number of Customers

The final equations from the previous section, reproduced below, show total wholesale route time as a function of the number of customers, route volume, route distance, and the volume per customer. (The reader is again reminded that these specific equations refer to wholesale deliveries when display case services are not provided by the route driver.)

$$T = 96.74 + 3.61C \\ + (0.08556\bar{V}_s - 0.0000806\bar{V}_s^2)C \\ + 1.11D \quad (6a)$$

$$T = 96.74 + 15.04C \\ + (0.024875\bar{V}_s)C + 1.11D \quad (7a)$$

At first glance it would appear that volume per customer ($\bar{V}_s$) has little or no effect on route time requirements, and such would indeed be the case if all other factors were held constant. This assumption is incompatible with a meaningful solution to the problem, however, for the effects of changes in volume per customer are primarily in terms of the changes that this permits in route organization and in total route volumes. In short, the several factors in the equations are not independent but interdependent. This is made quite clear when we note that $V_r = \bar{V}_s C$ or $C = V_r / \bar{V}_s$. If these interconnections are substituted in the above equations, we obtain:

$$T = 96.74 + 3.61 \frac{V_r}{\bar{V}_s} + 0.08556 V_r \\ - 0.0000806 V_r \bar{V}_s + 1.11D \quad (6b)$$

$$T = 96.74 + 15.04 \frac{V_r}{\bar{V}_s} \\ + 0.024875 V_r + 1.11D \quad (7b)$$

To simplify these equations further, we may ask what interconnections there are between distance and the other factors since changes in either route volume, number of customers, or volume per delivery might well be reflected in changes in route mileage. Analysis of the data for the routes studied, however, indicated that none of these factors—independently or in combination—had a significant effect on distance. Multiple correlation re-

sults indicated that neither the correlation nor the regression coefficients were of significant magnitudes. For this reason, the following computations have been based on a constant route distance of 36.3 miles per day, the average for all routes studied in California markets.¹⁵ Inserting this in the above equations yields the equations below, where time is expressed simply in terms of the two factors, route volume and volume per customer:

$$T = 137.03 + 3.61 \frac{V_r}{\bar{V}_s} + 0.08556 V_r - 0.0000806 V_r \bar{V}_s \tag{6c}$$

$$T = 137.03 + 15.04 \frac{V_r}{\bar{V}_s} + 0.024875 V_r \tag{7c}$$

Note that it would be appropriate to substitute the mileage figures for the different markets in determining specific relationships for individual areas.

We have now specified total route time as a function of route volume and volume per customer. Moreover, by selecting an appropriate length for the workday, these functions will enable us to represent route volume as a function of volume per delivery—the essential problem in determining the effect of volume per stop on delivery costs. While any length of workday could be selected, labor contracts in California markets specify the basic day as eight hours (exclusive of lunch periods), and most routes operate very close to this limit. The results of substituting $T = 480$ minutes in the above equations are shown in figure 10. Volume

¹⁵ The average route distances in the different markets ranged from about 17 miles per route in San Francisco to over 46 miles per route in Fresno.

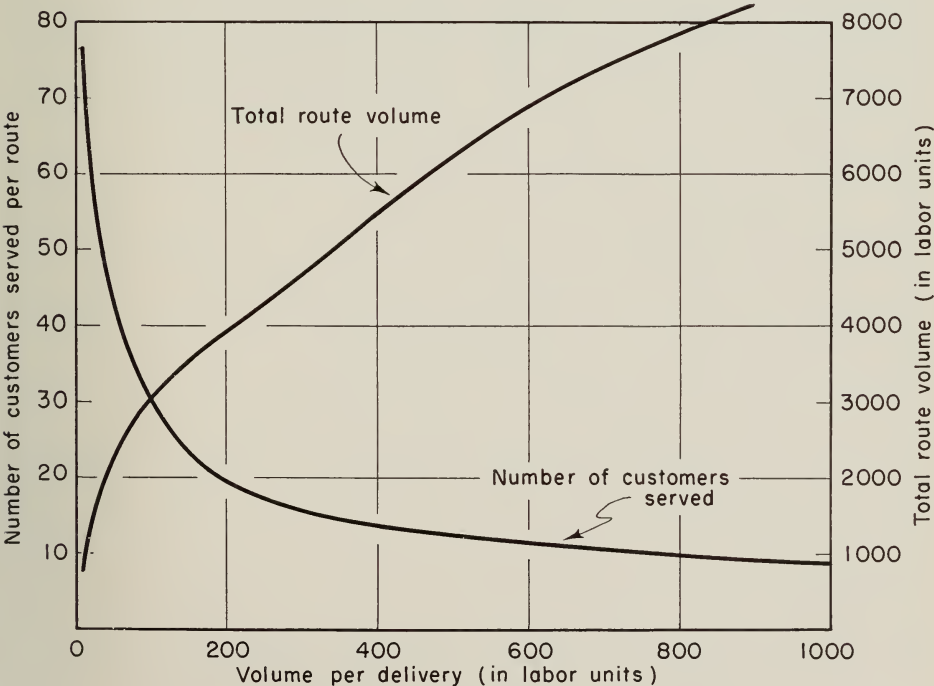


Fig. 10. Effect of volume per delivery on total route volume and number of customers served—wholesales milk routes.

per delivery is found to exert a most pronounced effect on route volumes, with total volume increasing at a decreasing rate to more than 8,000 units as average volume per stop increases up to 1,000 units.

Figure 10 also shows the effect of volume per customer on the number of customers served, obtained simply by dividing total volume by the volume per customer. As would be expected, this curve falls off rapidly in the low-volume-per stop ranges, and then more gradually as volume per stop exceeds 200 units. Both of these curves have been given as smooth, continuous functions. It is clear, however, that fractional customers are impossible and that both curves should therefore be discontinuous to reflect the discontinuous change in the number of customers. The discontinuities would be very small in the low-volume ranges, however, while in the higher ranges the tendencies for the curves to flatten out would reduce their importance. For these reasons, plus the fact that adjustments to whole customers may be made by obvious methods, the smooth curves are used here.

Effect of Volume per Stop on Total Delivery Time per Stop

The determination of total route volumes and customer numbers, as discussed in the previous section, simultaneously determines the allocation of total labor on a per stop basis. Heretofore, the only part of the route driver's time that could be allocated to an individual stop was that spent at the customer's premises (treated in the section concerned with direct delivery time). Driving time and miscellaneous route time, "indirect" from the standpoint of the contribution of any specific stop or stops, have been discussed only in terms of route totals.

The total time per stop—direct and indirect—has been determined by dividing the 480 minutes in an eight-hour day by the number of customers served per route (on the basis of the relationship discussed in fig. 10), and appears in figure 11. Since the number of customers served per route is a decreasing function of the average volume per customer, and the amount of indirect (driving and miscellaneous) time is constant per route, the resulting amount of indirect time per

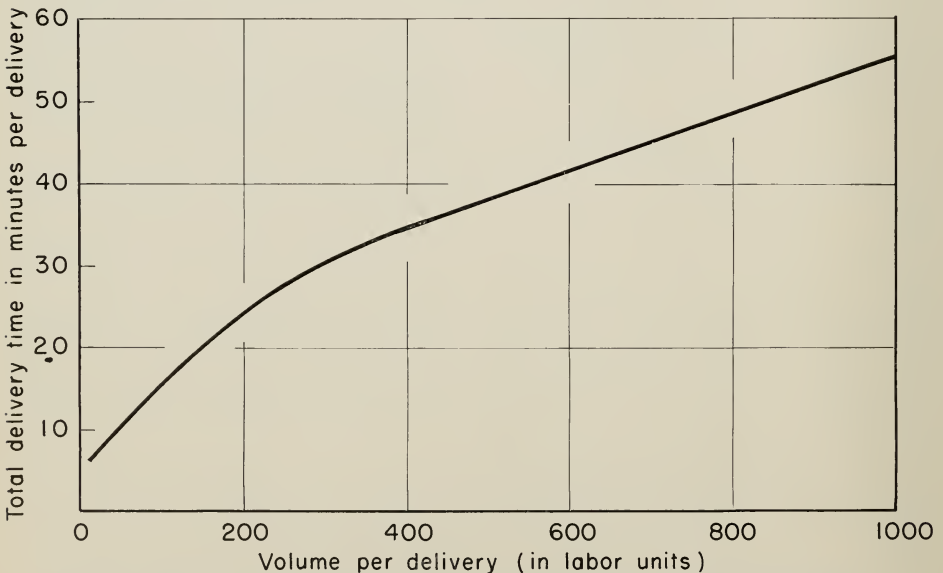


Fig. 11. Effect of volume per delivery on total delivery labor—wholesale milk routes.

stop is not constant, but is an increasing function of the size of stop. This procedure is the equivalent of using the ratio of the amount of indirect time per route

(137.03 minutes) to the number of customers, and combining it with the direct time relationship shown in figure 1 (p. 29).

Labor Costs per Stop—Wholesale

Time requirements per stop have been converted to labor costs by using the current union contract for the Los Angeles market and assuming a 6-day, 48-hour route week. Regular drivers average 44 hours per week and work 11 days out of each two-week period. Overtime is paid at the rate of time-and-a-half for work in excess of 40 hours per week, and 4 hours of overtime are guaranteed. Relief drivers are also paid on the same basis, but at a slightly higher hourly rate. Other labor costs include vacations, sick leave, health and welfare program contributions, and unemployment and compensation insurance. Details of these costs are given in table 15.

Using \$24.89 per day for route labor cost, the total delivery labor cost per stop appears in figure 12. Since wages and allowances paid to drivers for an eight-hour day under the Los Angeles contract are not influenced by size of stop or total volume, the direct determinant of labor cost per stop is the number of stops made—customers served (fig. 10). Dividing labor cost per day by the route volume, of course, would determine the labor cost per unit delivered.

It should be emphasized that the labor cost per stop relationship presented in figure 12 merely represents the physical time requirement data which appeared

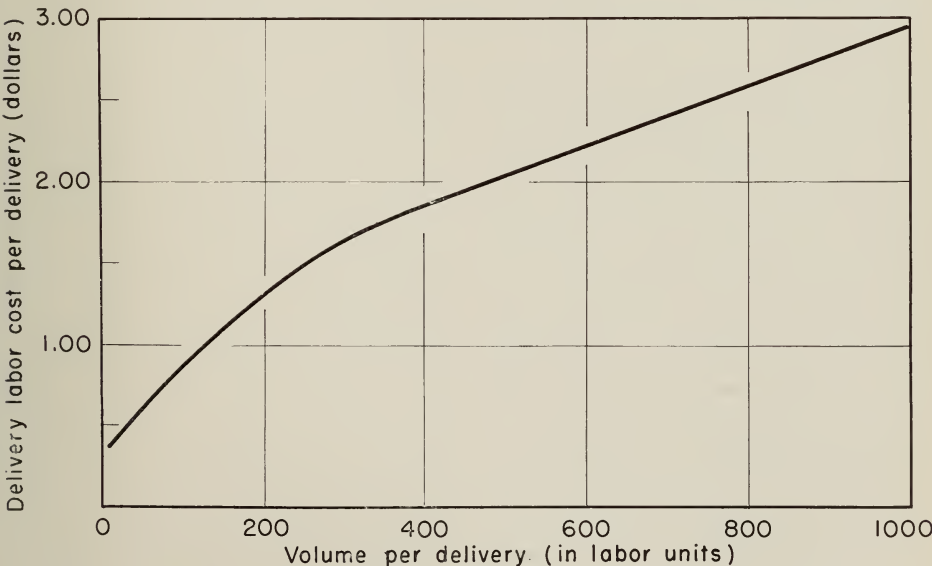


Fig. 12. Effect of volume per delivery on delivery labor cost per delivery, based on Los Angeles wage rates, 1955—wholesale milk routes.

Table 15. Calculation of Wholesale Delivery Labor Costs, Los Angeles Wage Rates, 1955

Factor	Rates per week
Regular driver.....	\$ 104.75
Relief driver.....	21.63
Foreman.....	5.53
Holidays, vacation, health and welfare.....	10.56
Unemployment taxes and com- pensation (3.67 per cent)....	5.23
Social security.....	1.66
Total labor cost per route per week.....	\$ 149.36
Labor cost per day (six-day week).....	\$ 24.89

in figure 11, converted to the currently appropriate labor cost per minute (about 5.2 cents). (This is, of course, appropriate only when wage rates are on a flat daily basis and no commissions or bonuses are involved which affect the labor cost per minute.) It is thus easily possible to make adjustments in labor costs for changes in the wage rates. Such changes will be reflected in a different labor cost per minute which, when applied to the basic physical input requirements, will provide an appropriate delivery labor cost relationship. Furthermore, wage rates prevailing in other markets may be applied to the physical relationship in order to determine approximate delivery labor costs in areas where delivery conditions and techniques are similar to those in Los Angeles.

Truck-Operating Expenses—Wholesale

The present study did not include an analysis of truck costs based on original records, but summary data of such costs were available in sufficient detail to provide the necessary information on the nature of these costs. The Bureau of Milk Control made an intensive study of processing and distribution costs for firms operating in several California markets during the last quarter of 1953. Included in these cost analyses is a breakdown of the elements of truck expense. These summaries contain both direct operating costs—such as gasoline and oil, tires, repairs, depreciation, taxes and licenses, et cetera—and indirect operating expenses, such as ice, supplies, laundry, and the general overhead allowances for the operation and maintenance of garage and storage facilities.

The total expenses in these categories applicable to wholesale milk delivery trucks, and the number of wholesale milk route days operated were made available by the Bureau for each of the firms studied. In addition, where possible, the total volume (in labor units) of milk products distributed during the three-month period was also provided. From this information, it was possible to calculate the average truck-operating cost per route day and the average volume per route for each of these companies. These averages have then been weighted by the number of routes operated, and are shown in figure 13. Since some companies operated larger trucks, carrying larger total volumes, than did other companies, these weighted averages indicate that the daily truck costs increase as the

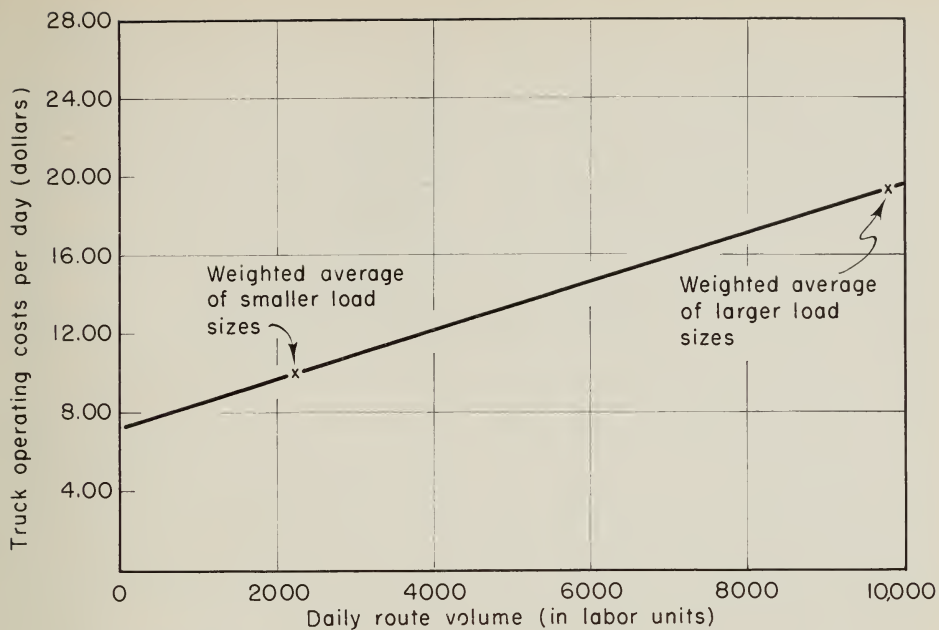


Fig. 13. Effect of route volume on daily truck-operating costs—wholesale milk routes.

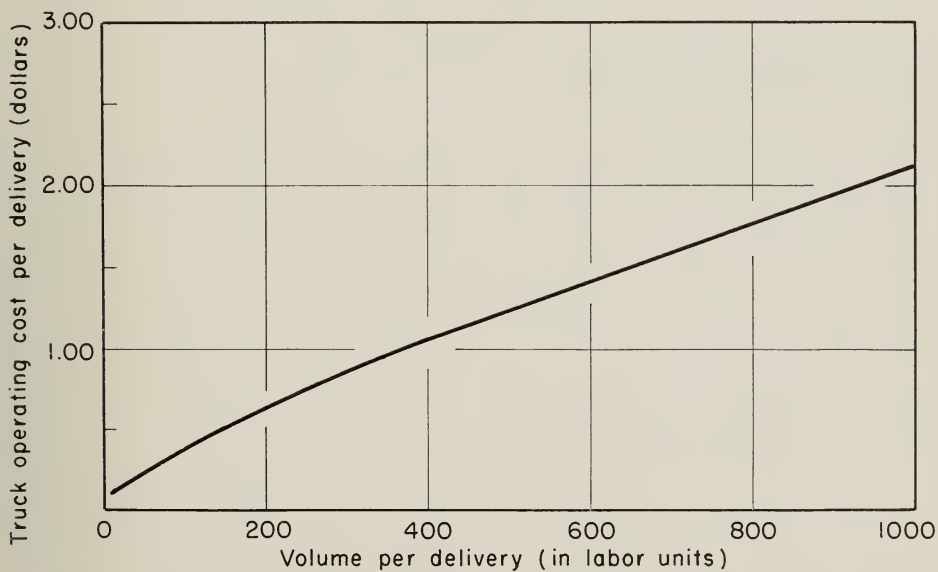


Fig. 14. Effect of volume per delivery on truck cost per delivery, Los Angeles, 1955—wholesale milk routes.

average size of load increases. The details of why these costs per day increase cannot be determined on the basis of the accounting records available. It would be logical to assume, however, that such factors as larger trucks being required to handle larger loads would have some influence. The larger truck, of course, would involve heavier depreciation charges, greater rates of gasoline, oil, and tire consumption, et cetera. If two trips are made with a smaller truck in order to handle the additional volume, then total route mileage would be increased and again truck costs per route day would increase.

A straight-line relationship has been determined on the basis of the weighted averages of the four smaller load sizes and of the two larger load sizes. The equation describing this relationship is:

$$TC = \$7.41 + 0.0012226 V_r \quad (11)$$

where TC represents truck-operating ex-

penses per route day, and V_r represents the total volume handled per route, expressed in labor units. Estimates of the total truck costs per day for different sized routes can be calculated from this relationship. Knowing the route volume and the number of customers served (per eight-hour route day) that are associated with various sizes of customer stops (from fig. 10), calculations can be made of truck-operating cost per stop by methods already described. These costs are shown in figure 14.

As was the case in the consideration of labor costs, the basic determinants of truck costs are the physical input requirements which were developed from the time study analyses. So long as technology and the conditions of delivery in the market remain unchanged, these input requirements will be unaffected. Changes in costs resulting from changes in the level of prices and cost rates can then be adequately accounted for if the new cost rates are known.

Total Delivery Costs—Wholesale

Labor costs and truck costs can now be combined to show the effect of volume per stop on total delivery costs. Figure 15 represents the *cost per stop* for providing the full set of service operations to customers receiving different volumes. Although this relationship is curvilinear, it may be well approximated by the use of the two linear functions shown in the figure. The equations describing these linear approximations are:

$$C = \$0.35 + \$0.00844 V_s \quad (12)$$

which is applicable for volumes per stop of less than 221 labor units; and,

$$C = \$1.43 + \$0.00355 V_s \quad (13)$$

which will approximate the delivery cost of stops where more than 221 labor units are delivered. In both instances, C represents the total delivery *cost per stop* and V_s the volume of milk products per stop measured in terms of total units.

As can be seen from this diagram, total delivery costs increase with increases in the size of delivery, but at a less than proportionate rate. This means, for example, that it does not cost as much to make one 400-unit stop as it does to make four 100-unit deliveries. Furthermore, there is a certain amount of fixed cost involved in making a customer stop which is independent of the volume being delivered—which at present cost rates amounts to about 35 cents. When converted to terms of the delivery cost per

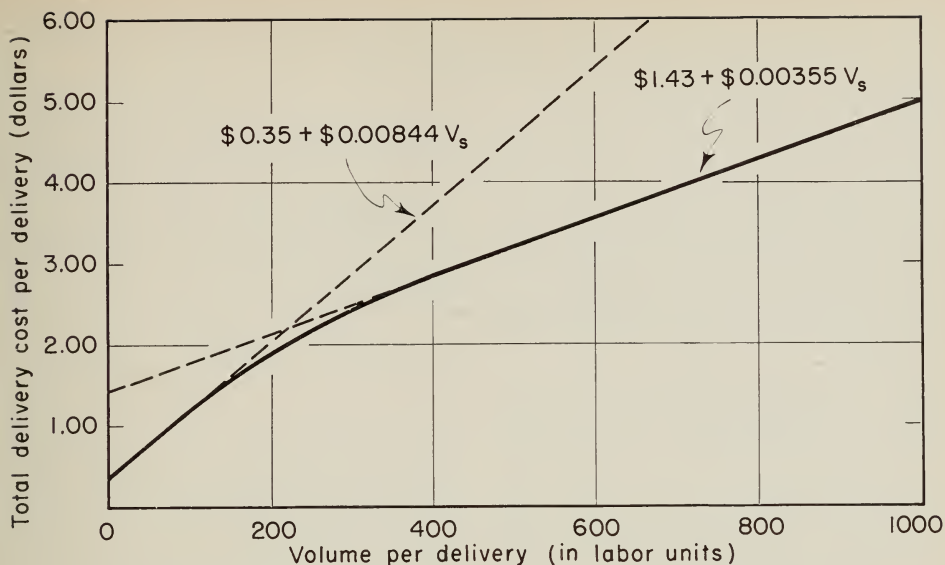


Fig. 15. Effect of volume per delivery on total delivery costs per delivery, based on Los Angeles cost rates, 1955—wholesale milk routes.

unit (fig. 16), this relationship points out that delivery costs are high for small-volume deliveries and that these costs fall rapidly as the volume per stop in-

creases until a volume of about 200 labor units is reached, and then decline much more slowly for deliveries larger than this amount.

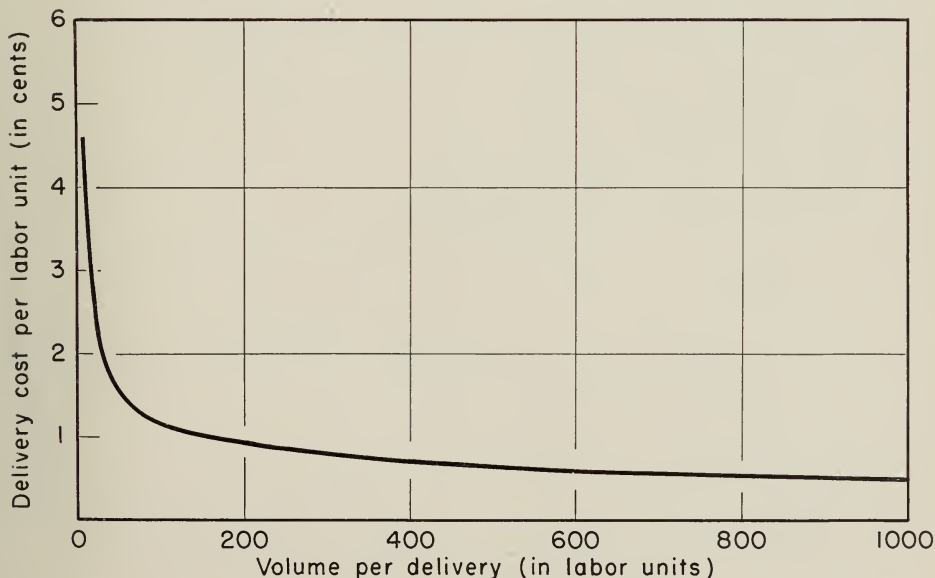


Fig. 16. Effect of volume per delivery on total delivery costs per labor unit, based on Los Angeles cost rates, 1955—wholesale milk routes.

Cost-Volume Relationships in Retail Milk Delivery

The same type of analysis presented for wholesale deliveries has been made to determine the influence of volume per serve on the several cost-influencing variables involved in making milk deliveries to homes.

Effect of Volume per Stop on Route Volume and Number of Customers

Recalling the previous development of the time requirements for retail milk routes, the final equation from the earlier section is reproduced below:

$$T = 40.66 + 0.7706C + 0.1178V_r + 0.0051\bar{F}C + 2.37D \tag{10b}$$

By substituting the relation $C = V_r / \bar{V}_s$, and inserting the average distance per delivery trip as determined from the

routes studied (132.5 feet) for $\bar{F}$ and further substituting the average retail route mileage (33.7 miles), the equation simplifies to:

$$T = 120.53 + 1.4464 \frac{V_r}{\bar{V}_s} + 0.1178V_r \tag{10c}$$

which expresses total route time in terms of the two variables, the volume per stop and the total route volume. Since retail routes in California are also normally organized on an 8-hour basis, we substitute 480 minutes in the above equation to determine the effect of variations in volume per stop on total route volumes and number of customers served per route day. The results of these interrelationships are shown in figure 17. Volume per stop has a definite influence on daily route volumes where total load sizes in-

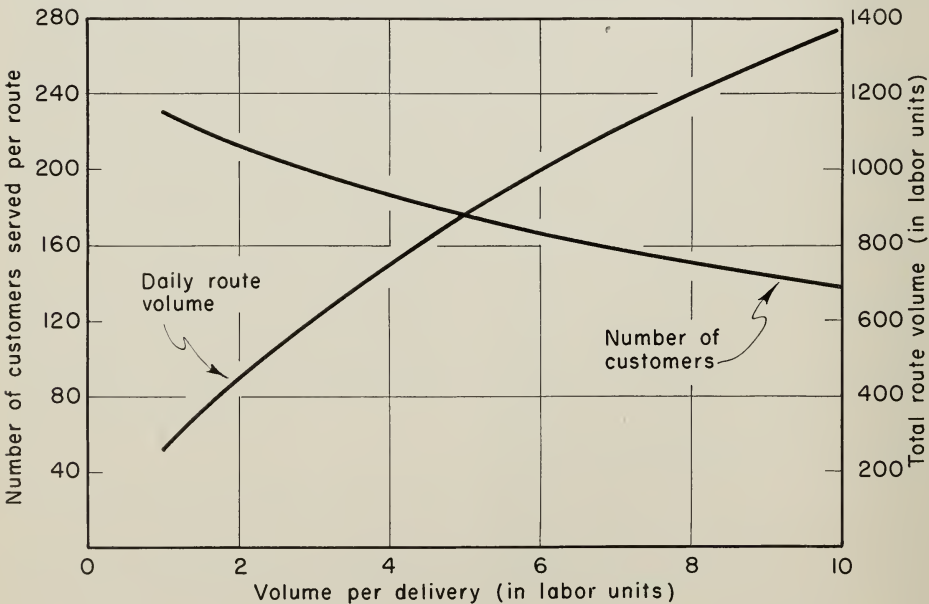


Fig. 17. Effect of volume per delivery on total route volume and number of customers served per route, Los Angeles and Fresno markets combined, 1954—retail milk routes.

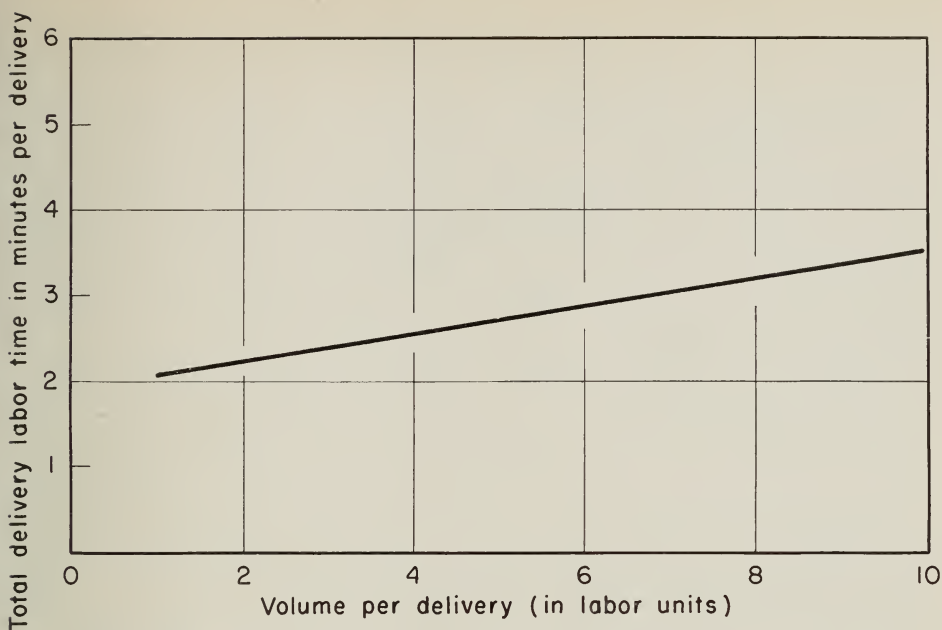


Fig. 18. Effect of volume per delivery on total delivery labor, Los Angeles and Fresno markets combined, 1954—retail milk routes.

crease from less than 250 units with an average of 1 unit per delivery to nearly 1,300 units when 10 units are served per customer. The decrease in number of customers per route with increased delivery sizes reflects, of course, the fact (shown in fig. 9, p. 44) that total direct time requirements are greater for large than for small-volume customers.

Effect of Volume per Stop on Total Delivery Time per Stop

The influence of delivery volume on

delivery time per stop is shown in figure 18. This has been obtained by dividing the 480 minutes per day by the number of customers per route as determined in figure 17. As mentioned in the wholesale route study discussion, this is the equivalent of assigning the "indirect" time—such as driving time and miscellaneous route time—in ratio to the number of customers served per route (a decreasing function of delivery size) and adding this allocation of indirect time to the direct time requirements presented in figure 9 (p. 44).

Labor Costs per Stop—Retail

The time requirements per stop have been converted to labor costs by applying appropriate wage rates. In all California markets, except Los Angeles, wages paid retail route drivers are on a straight salary basis. In other words, the total wage cost per day is constant, regardless

of route volumes. In Los Angeles, however, a change was made in wage payments which incorporates a guaranteed base plus a commission on all deliveries in excess of a basic quantity. Since this basic volume is lower (423 units) than average load sizes in the market (473

Table 16. Calculation of Retail Delivery Labor Costs, 1955 Wage Rates*

Factor	Rates per week
Regular driver.....	\$ 86.60
Relief driver.....	35.82
Foreman.....	4.52
Holidays, vacation, health and welfare.....	13.83
Unemployment taxes and compensation (3.67 per cent)....	5.17
Social security.....	1.94
Total labor cost per route per week.....	\$ 147.89
Labor cost per day (seven-day week).....	\$ 21.13

* These wage rates do not apply to any specific market, but are based on levels appropriate to the current Los Angeles rates when calculated on the basis of the average commissions.

units when studied in 1954), most routes involve some commission payments.

The type of wage payment, of course, influences the labor cost per minute. Under a straight wage payment, the per minute cost is constant and may be obtained simply by dividing the total daily labor cost by the minutes worked per day. On the other hand, where a commission arrangement is involved, the total daily labor cost is a function of total route volume, and thus the cost per minute is variable with different load sizes.

In view of the prevalence of the former system in most California markets, the following discussion assumes a flat wage-payment system. Table 16 presents the computations entering into the determination of daily retail labor costs.

Based on \$21.13 per day, the total re-

tail delivery labor cost per stop appears in figure 19. It is again emphasized that this figure merely represents the basic physical time requirements shown in figure 18, converted to dollar costs by applying the cost per minute (4.4 cents) applicable to present labor costs. Adjustments can be made to account for different labor costs in other markets, or for changes in wage levels, merely by applying the appropriate labor costs (in cents per minute) to the basic physical time requirements from figure 18. It should again be noted that the specific nature of this labor-cost relationship depends upon the type of wage agreement in effect. The costs shown in figure 19 are based on conditions where a flat wage is paid—that is, where the cost per minute is constant for any route volume. Where wages are based in part or in whole on commissions, the cost per minute increases as a function of route volume. This in turn is directly related to volume per stop, and the cost per minute thus increases with increases in delivery volume. For this reason, the slope of the labor cost-volume per stop relationship will be steeper under commission than under flat salary arrangements. Note should be made of the effect of a combination of a guaranteed base and commission, such as currently exists in Los Angeles, on the nature of this cost-volume relationship (fig. 20). Until route volumes appropriate for the level of the base volume are reached (consistent with average deliveries of less than 3 units), the labor costs per day are constant, and the slope of the relation is comparable with that in figure 19. For route volumes in excess of the base volumes, the commission becomes effective, and the slope of the cost-volume relation increases. Therefore, in total, this curve is “kinked” in an upward direction as illustrated in figure 19.

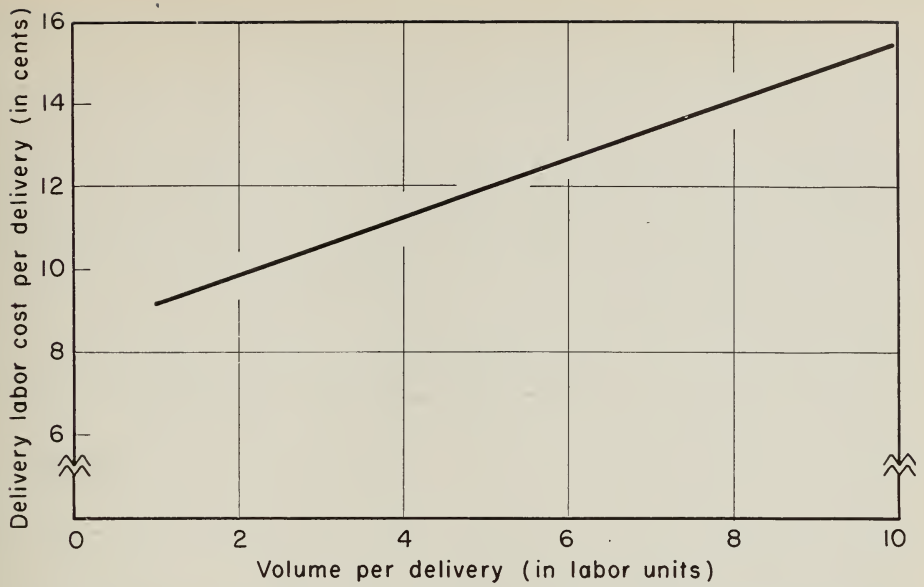


Fig. 19. Effect of volume per delivery on delivery labor cost per stop, Los Angeles and Fresno markets combined, 1954—retail milk routes.

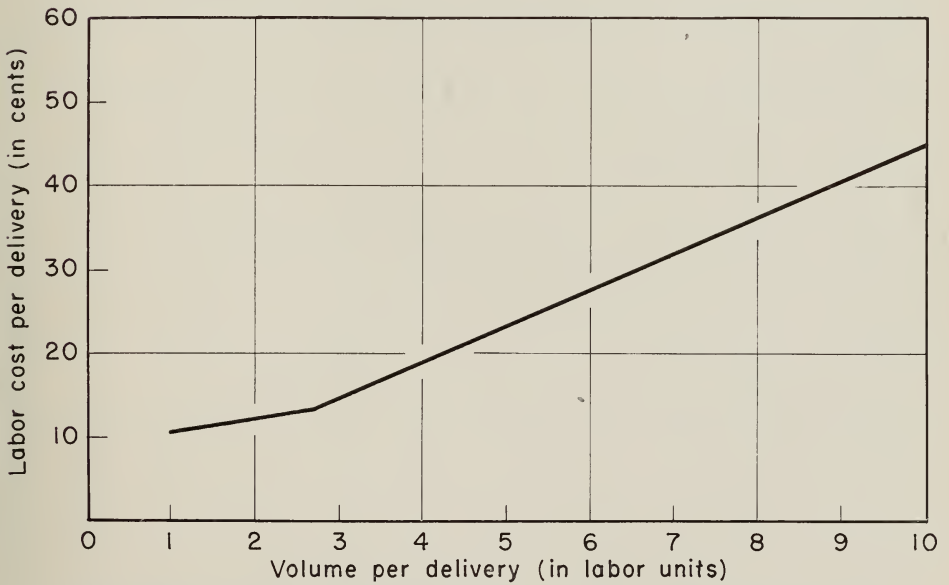


Fig. 20. Effect of volume per delivery on labor cost per delivery, Los Angeles, 1955—retail milk routes.

Truck-Operating Expenses—Retail

The Bureau of Milk Control studies were drawn upon again to determine the level of retail delivery truck-operating expenses. These studies were in sufficient detail to provide accounting-type data on such fixed cost elements as depreciation, licenses and taxes, and garage overhead, as well as such operating expenses as gasoline, oil, tires, repairs, and other relevant items. The period for which these studies were made was the last quarter of 1953.

An analysis of the records of eight plants operating a total of 915 retail routes in the Los Angeles and Fresno markets indicated an average daily truck-operating cost of \$6.56. Although some variation in volumes per route existed, these differences did not involve substan-

tial differences in type or size of truck, and no relationship between average route volumes and average truck-operating costs was found. It is recognized that load sizes consistent with the larger average delivery volumes—as high as 1,350 units, for example—would undoubtedly involve larger trucks than are currently used, with correspondingly higher operating costs. In the absence of data on the operating costs of these larger trucks, it is arbitrarily assumed that the daily truck expenses for a route operating with double the present average volume will be higher than the present costs by 25 per cent. This is assumed for the following reasons: First, it is logical to expect that, while operating expenses increase with load sizes, they increase substan-

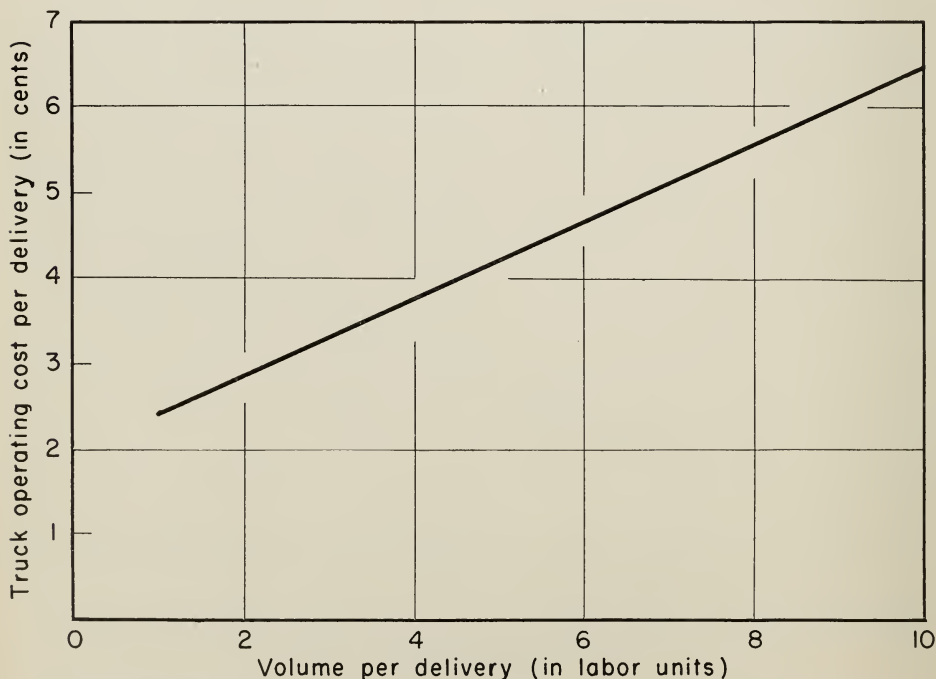


Fig. 21. Effect of volume per delivery on truck cost per delivery, based on cost rates in Los Angeles and Fresno, 1953—retail milk routes.

tially less than in direct proportion to total volume. Second, this is approximately the rate of increase shown for wholesale trucks in figure 13, between current levels at the average volume and those for double that volume. On the basis of this assumption, therefore, retail truck-operating costs may be expressed

$$T_c = \$4.92 + \$0.002867V_r \quad (14)$$

where T_c represents total daily truck-operating costs, and V_r the volume per route, measured in labor units. This, applied to the current problem of determining truck-operating expense per stop for deliveries of varying volumes, provides the results shown in figure 21.

Total Delivery Costs—Retail

Figure 22 shows the *combined* elements of labor costs and truck expense per stop on retail delivery volumes. This function is linear and can be represented by the equation:

$$C = \$0.105 + \$0.0114V_s \quad (15)$$

where C represents total delivery cost per stop, and V_s the volume per stop. From

this it can be seen that costs per delivery increase with volume per serve, but at a less than proportional rate. There is, furthermore, a certain amount of delivery cost (10.5 cents) which is not associated with volume of delivery but is fixed or constant per customer served. The same information on total delivery cost, when converted into unit terms, is shown in figure 23. This points out that delivery

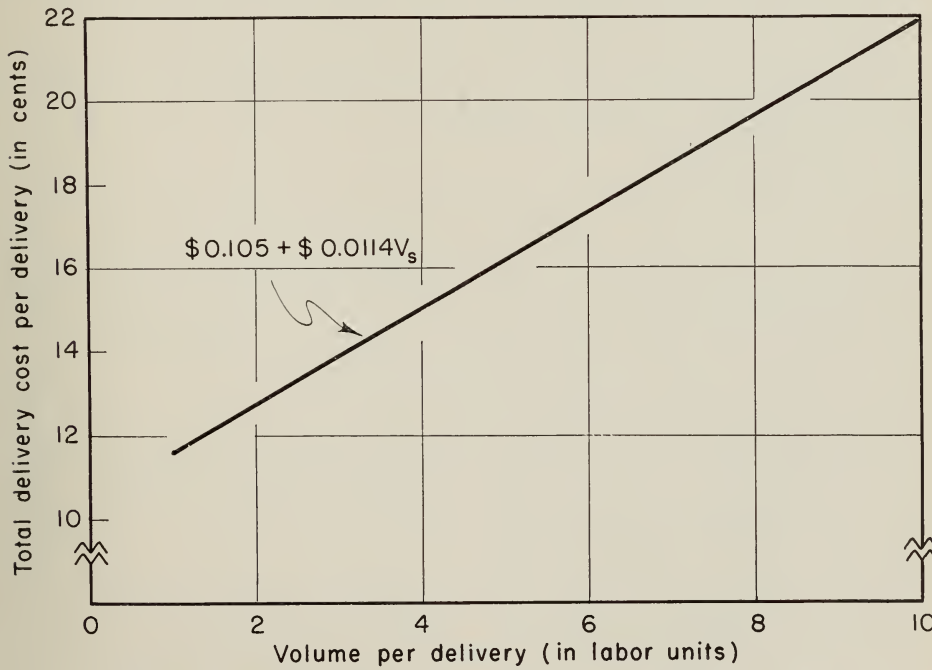


Fig. 22. Effect of volume per delivery on total delivery cost per delivery, California markets, 1955—retail milk routes.

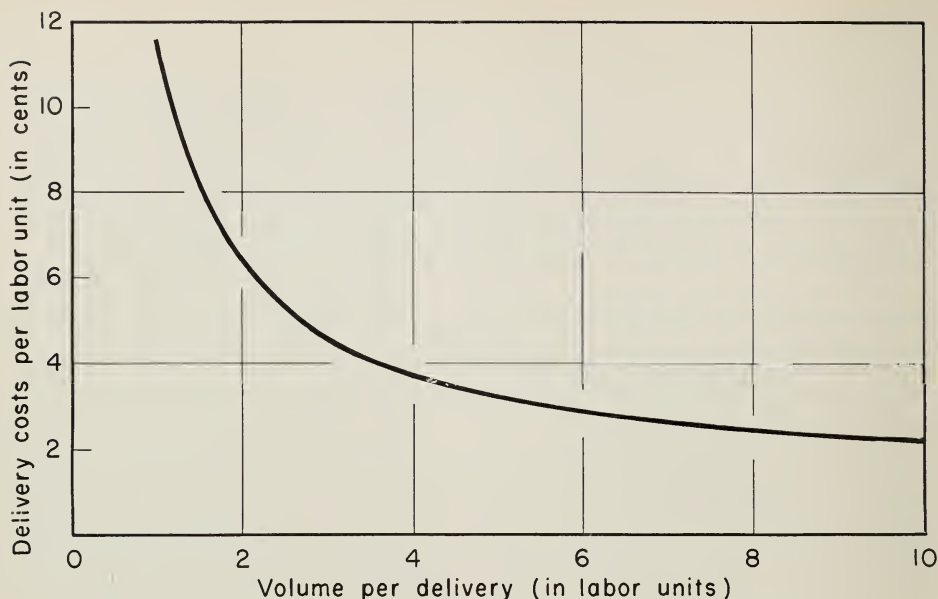


Fig. 23. Effect of volume per delivery on total delivery costs per unit, California markets, 1955—retail milk routes.

costs per unit are very high for small volumes of delivery (over 11.5 cents for 1 unit per stop), fall off rapidly as de-

liveries increase to about 4 units, and then decline much more slowly for deliveries in excess of that amount.

Distribution Costs Other Than Delivery

The major cost-volume relationships for milk delivery are developed in the section beginning on page 46. To summarize briefly, the findings emphasize the fact that unit costs are not constant, but decrease rapidly with increases in the volume per customer. Thus, figure 16 (p. 53) shows that wholesale delivery costs dropped from 5 cents per labor unit, with a volume of 10 labor units per customer delivery, to about 1¼ cents per unit with a volume of 100 units, and that they continued to decline, but at a decreasing rate, to approximately 0.5 cent per unit with a volume averaging 1,000 units per customer. Similarly, figure 23 indicates that retail home-delivery costs

are about 11.5 cents per quart for a one-quart delivery, and fall off rapidly to about 2 cents per quart when 10 quarts are delivered to a single customer.

While it is possible to conceive of a system in which products and the associated services would be priced independently, it seems more practical to consider them as joint, and covered by a single price. In order to consider the appropriate pricing for this joint product, then, composite costs for the product plus the services must be available. In the case of milk, this means that costs and allowances covering the product up to the delivery operations must be ob-

Table 17. Calculation of Nondelivery Costs per Quart for Wholesale and Retail Milk Sales, Los Angeles, 1955

Factor	Wholesale	Retail
	cents	cents
Current price.....	17.50	21.50
Average delivery cost per unit*.....	1.25	4.76
Nondelivery costs and margins.....	16.25	16.74

* Determined by the present study on basis of average deliveries of 87.7 and 2.9 labor units per serve to wholesale and retail customers, respectively.

tained and added to the delivery cost functions. These nondelivery costs include: the raw product cost (the farm price for the milk plus transportation and handling charges involved in moving it from the farm to the city plant); processing or city plant costs, including receiving, pasteurizing, and bottling expenses; and general overhead and ad-

ministrative costs plus allowable profits. While such cost estimates must be used, a detailed study of these phases of milk distribution and of producer pricing has not been included in the present project. The prices established by the Bureau of Milk Control, and the findings of the Bureau's studies of distribution costs have been accepted without ques-

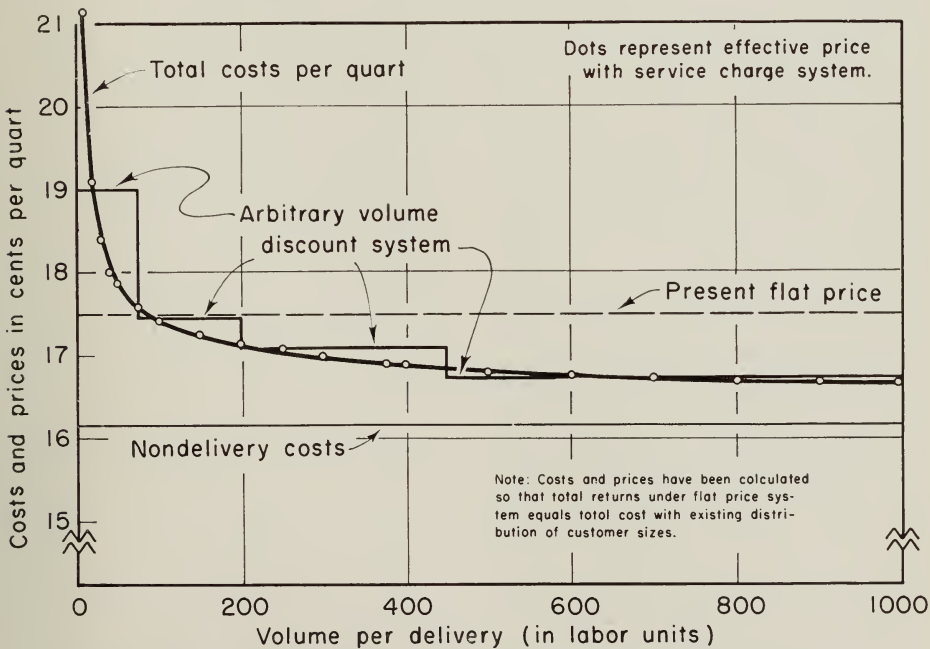


Fig. 24. Comparison of total unit costs with returns under alternative pricing systems—wholesale sales.

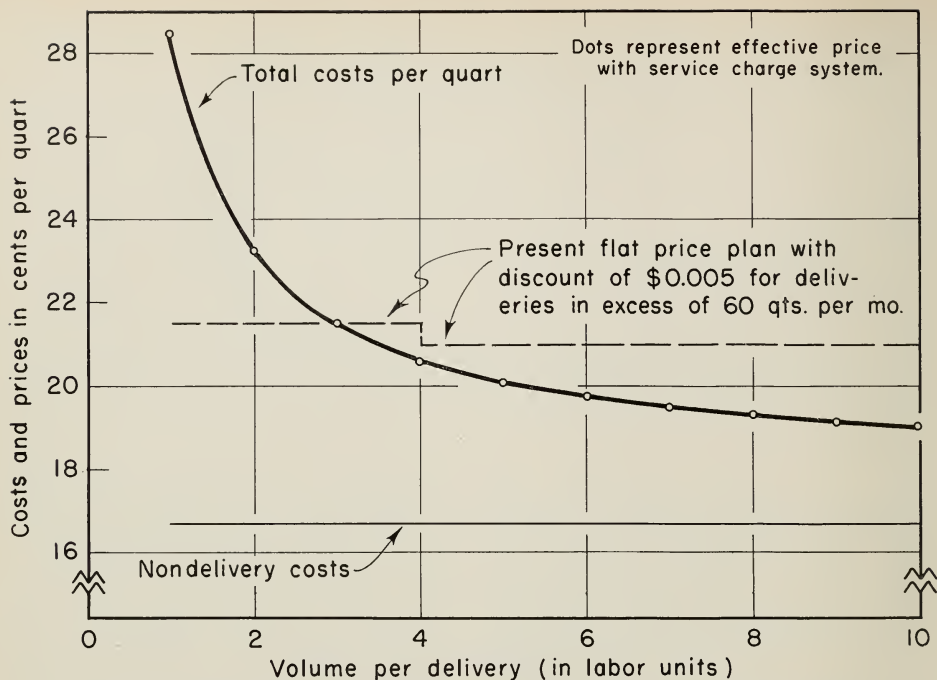


Fig. 25. Comparison of total unit costs with returns under alternative pricing systems, based on Los Angeles cost levels, 1955—retail sales.

tion. This procedure of determining the level of nondelivery costs assumes, of course, that current established price levels are in line with levels of costs. The discussion to follow centers on differences in delivery costs, and is not concerned with the question of whether or not the *levels* of existing price spreads are appropriate.

To arrive at the levels of nondelivery costs, the *average* delivery cost per unit for the market—as determined from this study—was deducted from the unit price in effect. For the purpose of illustration, the prices currently (February, 1956) received by distributors for fluid milk in quarts delivered to customer's location in Los Angeles will be used. These prices are 17.5 cents for wholesale sales and 21.5 cents for retail, home-delivered sales. (The home-delivered price in Los Angeles is now subject to a $\frac{1}{2}$ cent per quart discount when deliveries are made in excess of 60 quarts per month. This

discount is ignored in these calculations to simplify the discussion of technique.) Average delivery volumes for the same market (87.7 labor units for wholesale deliveries and 2.9 labor units for retail deliveries) are also applied. The appropriate calculations are shown in table 17.

These nondelivery costs of 16.25 cents per quart (wholesale) and 16.74 cents (retail) are not influenced by volume per stop, and consequently are shown by the solid horizontal, straight lines labeled "nondelivery costs" on figures 24 and 25. To these are added the delivery costs per unit presented in figures 16 (p. 53) and 23, and these combined delivery and nondelivery costs represent total unit costs to distributors. The latter costs are represented by the curved lines labeled "total costs per unit." This procedure makes the total revenue to distributors under the flat price system just equal to the total costs with the existing distribution of customer sizes.

Comparison of Alternative Pricing Systems

Three pricing plans will be considered in terms of their adequacy in reflecting costs and their simplicity of application and enforcement: (1) flat pricing, as under the present system; (2) a system of service charges per delivery; and (3) volume discount schedules. While these by no means exhaust the possible pricing plans, they include the more common proposals, and should be sufficient to illustrate the problem.

Flat pricing. The system of flat pricing simply means that all customers, regardless of size, are charged a uniform price per quart of milk. This is the present system in most California markets. Flat price plans for the Los Angeles market are shown by the horizontal dotted lines in figures 24 and 25 (pp. 61 and 62). They are, of course, completely unrealistic as a representation of distribution costs. In the volume ranges below 90 units per customer, actual wholesale costs exceed the fixed price; above this volume, costs are below the price. Similarly, for retail deliveries below 3 units, the price is substantially below costs, while the reverse is true for the larger delivery volumes. The system does have the advantages of simplicity and familiarity, but it should be pointed out that, in many milk markets, the established prices may be merely nominal—that is, they may be coupled with open or hidden discount schedules.

Service charges. The fact that an important part of the cost of servicing a customer tends to be fixed or constant regardless of the volume delivered has sometimes been used as the basis for a pricing plan involving a fixed service charge per delivery plus a flat price per quart delivered. (The "Elwell Plan," [p. 14] is a form of service charge pricing.)

Referring again to figures 24 and 25 (pp. 61 and 62), it will be seen that total wholesale delivery cost *per stop* could be represented very closely by a fixed charge of 35 cents plus a variable charge of .884 cent per unit in the volume range below 221 units. Adding the 16.25 cents per unit for other costs and margins, a pricing plan is derived with a service charge of 35 cents per delivery and a flat price of 17.1 cents per quart. Because total costs per stop increase at a decreasing rate in the higher volumes, the ranges above 221 units would be overpriced relative to costs, by the above plan, but these costs could be approximated quite closely by a service charge of \$1.43 with a flat price of 16.6 cents per quart. A plan determined in a similar manner for retail deliveries would involve a flat charge of 10.5 cents per delivery and a uniform price of 18 cents per quart. The effective average prices for selected delivery sizes which would result from the use of these two plans are shown by the large dots in figures 24 and 25 (pp. 61 and 62). The merit of both plans is that they reflect the calculated costs almost exactly.

Since they merely involve somewhat lower flat prices plus fixed service charges per delivery, such plans should not represent a significant complication in billing customers. Failure to report correctly the number of deliveries made might well result in enforcement difficulties, especially if smaller wholesale customers adopted alternate-day deliveries, but this problem seems less complicated than the present one of policing the inequitable flat price plan. An additional feature of this plan would be to encourage the consolidation of small-volume wholesale customers through every-other-

day delivery. In this way, such customers could reduce the unit cost.

Possibly the greatest limitation to service charge plans in California markets is that they represent departures from established practices and might therefore be viewed by distributors and customers with the same suspicion that characterized the early period of alternate-day retail delivery.

Volume discounts. The dairy industry has had a long experience with volume discounts. Such a system, used almost universally by all types of wholesale marketing agencies, consists simply of a schedule of percentage discounts, on quoted prices, that will be allowed for purchases of specified quantities. Applied to the present problem, the important question becomes one of determining a base price and discount schedule that will reflect, at least approximately, the cost relationship (pp. 61 and 62). It is quite clear that costs could be reflected with any desired degree of accuracy if complicated schedules with large numbers of volume classes were permitted. As a practical matter, however, the schedule will need to be limited to relatively few classes. It is also possible that the volume classes may be defined in terms of labor units or cases, or that roughly the same effect could be obtained through definitions in terms of dollar values per day, per week, or per month. With a system

of discounts on a base price, the average price will be lower than the base. Therefore, to yield the same average returns, the base price must be high relative to a flat price. Practical considerations of public price administration preclude the use of "too high" a price, such as might be consistent with costs for very small volume deliveries. Instead, such a system will underprice milk for small stops and average this out by overpricing certain volume groups near the end of the discount bracket.

An arbitrary discount schedule for wholesale sales has been selected, based on four classes and a "base" price of 19 cents. This schedule is given in table 18 and has been drawn in figure 23 (p. 60) as a series of steplike reductions. Allowing for the fact that this schedule includes only four classes, the base price and discounts appear to be fairly well centered on the cost curve. With a base price of 19 cents, the schedule must, of course, fail to reflect completely the actual cost involved in servicing very small stops, but the general nature of the price changes tends to follow costs. The schedule is not complicated, nor would it involve radical changes in billing methods.

Some of the major limitations of a volume discount system which brackets more than one delivery volume are best illustrated by retail deliveries. As emphasized in figure 24 (p. 61), costs per unit fall off rapidly with each additional unit delivered, particularly in the smaller volume ranges. Thus, the costs indicated for a 1-unit retail delivery are about 28.5 cents, while for 2 units, the cost per unit is about 5 cents lower. Let us assume, for example, that 1- and 2-unit deliveries were bracketed at 26 cents per unit. This certainly would reflect costs for these small deliveries more closely than does the present uniform price system which involves a 21.5-cent price for all delivery sizes. But it would have the obvious disadvantage of underpricing one-quart stops by about 2.5 cents while overpricing

Table 18. Arbitrary Volume Discount Schedule

Volume per delivery	Percentage discount	Effective prices
labor units		dollars
0-74.....	0	0.1900
75-224.....	8	0.1748
225-449.....	10	0.1710
450 and over...	12	0.1672

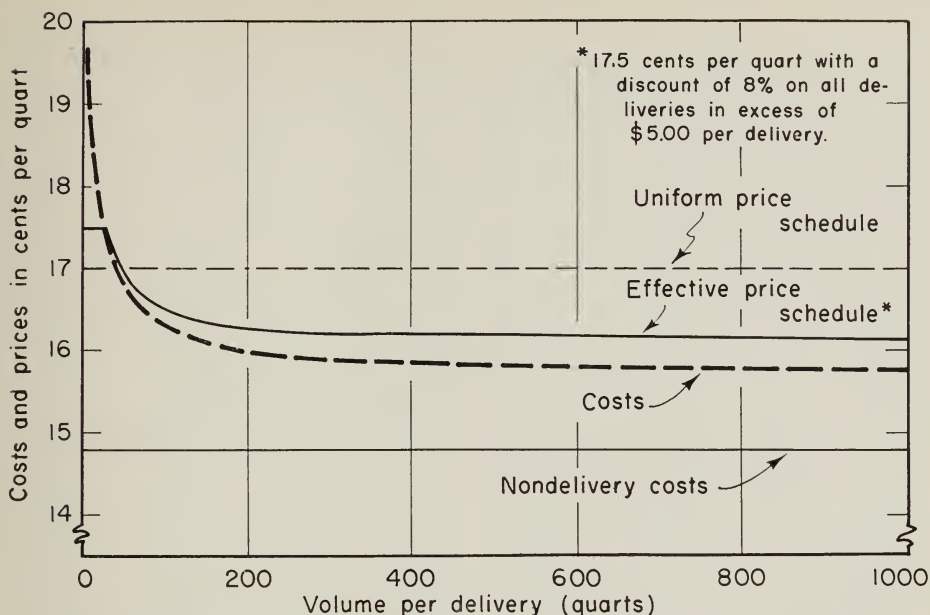


Fig. 26. Comparison of costs per quart with alternative price schedules, Fresno, 1955—wholesale milk deliveries.

ing the two-quart stops by slightly more than this amount. Furthermore, it would provide no price incentive for one-quart customers to increase their volume per stop either through a reduction in number of deliveries or by consolidating store and home-delivered purchases unless, as a result, the customer buys at least three quarts per delivery.

The inadequacy of a $\frac{1}{2}$ -cent-per-quart discount on deliveries in excess of 60 quarts per month (equivalent to 4 units per delivery on an every-other-day basis) can also be seen from figure 24 (p. 61). At best, this system provides a slight recognition of the cost differences in large versus small deliveries.

It is, of course, possible to devise several types of volume discount schedules in addition to that described above. In California, the Bureau of Milk Control is currently in process of adopting a system of volume pricing which involves a single discount figure on all sales in excess of a stated amount. The wholesale price plan for the Fresno market—the first to become effective—stipulates a

base price of 17.5 cents per quart with a discount of 8 per cent on all milk sales in excess of \$5 value per delivery. This is equivalent, in physical terms, to about 29 quarts per stop. All customers, therefore, pay at the rate of 17.5 cents for the first 29 quarts, and 16.1 cents for all additional quarts. The effect of this price schedule in the Fresno market is shown in figure 26 and is compared with a uniform price in relation to costs determined for that market.

The effect of reduced services on prices. All of the preceding discussion of pricing plans has presumed levels of delivery cost consistent with a complete set of services provided by the route driver (so-called “full-service” operations). As pointed out in table 11 (p. 35), however, substantial reductions in wholesale delivery time requirements occur when some of the elements commonly performed by the routeman are eliminated. It will be recalled that three types of service categories were compared. Type “A” referred to the full set of service operations, type “B” to a situation

Table 19. Comparison of Route Volumes and Unit Delivery Cost with Alternative Combinations of Delivery Services

Size of stop	Volume per route			Delivery cost per unit		
	"A"	"B"	"C"	"A"	"B"	"C"
labor units	labor units			dollars		
10	769	1,438	2,085	.0432	.0237	.0167
20	1,297	2,373	3,413	.0261	.0148	.0107
30	1,685	3,030	4,330	.0204	.0119	.0087
40	1,987	3,518	5,007	.0175	.0104	.0077
50	2,231	3,892	5,523	.0157	.0095	.0071
75	2,688	4,537	6,399	.0132	.0083	.0063
100	3,019	4,949	6,957	.0119	.0077	.0059
150	3,518	5,444	7,622	.0104	.0072	.0055
200	3,920	5,726	7,995	.0095	.0069	.0053
250	4,298	6,060	8,365	.0087	.0066	.0051
300	4,673	6,471	8,978	.0081	.0062	.0048
400	5,488	7,086	9,884	.0071	.0058	.0045
500	6,236	8,225	11,349	.0064	.0052	.0041
600	6,873	9,146	12,702	.0059	.0048	.0038
700	7,393	9,941	13,829	.0056	.0045	.0036
800	7,848	10,651	14,847	.0053	.0043	.0034
900	8,244	11,245	15,733	.0051	.0041	.0033
1,000	8,596	11,786	16,489	.0050	.0040	.0032

in which the driver knew the amount of the order in advance and in which collections were made by mail, and type "C" in which the routeman performed a minimum set of services—merely dropping the product on the sidewalk or at the shipping dock.

Table 19 shows the effect of these reduced service combinations on total wholesale route volumes as well as on the unit delivery costs for varying sizes of stops. Calculations have been made to reflect these lowered costs resulting from

reduced services within the framework of the service charge pricing system. With type "B" services, all costs—including delivery and nondelivery—could be adequately covered for volume ranges of less than 200 units by a service charge of 18 cents plus 16.75 cents per quart. For type "C" services, for the same range of volumes, a charge of 12 cents plus 16.65 cents per quart would be sufficient. Type "A" services, on the other hand, require a service charge of 35 cents plus 17.1 cents per quart delivered.

Summary and Conclusions

This study traces the development of milk distribution in California markets and points out how the established system of flat pricing regardless of volume per

delivery encourages the development of certain undesirable practices, such as hidden rebates and the growth of captive creameries. Perhaps more important,

flat pricing not only encourages such inefficiencies as having a single customer served by a number of distributors, but by failing to reflect real economies through appropriate price reductions, also fails to provide an incentive for consumers to select more efficient methods.

Results of delivery costs studies in several markets have been summarized in terms of cost curves that show the tendency for average costs to decline with increases in volume per customer. These cost relationships have been used to emphasize the inadequacy and inequity of the existing system of flat pricing and to appraise several alternative systems. A system of service charges coupled with reduced levels of flat prices could reflect actual costs and margins quite accurately, although the newness of the idea might lead to initial objections by the industry. A system of volume discounts would not be strange to the industry and, while necessarily less accurate than the system based on service charges, would be greatly superior to the present price plan in reflecting economies of large-scale delivery.

Investigations also showed that substantial savings in both money and manpower could be made through streamlining the types of services rendered by the wholesale route driver. While these savings would be compensated for in part by additional expenditures elsewhere (such as increased bookkeeping resulting from telephone orders and from billing and collecting by mail), these additional costs are not likely to be large in relation to the gross saving. In many instances, certain operations now performed by the route driver could be shifted to store personnel during slack periods and "off hours" of sales activity.

Total benefits from increased economies under the present type of milk price administration would be conditioned by further policies adopted by the control agency—particularly with respect to out-of-store retail pricing. Direct advantages,

in terms of lower cost and corresponding narrower spreads, could result even without a direct pricing policy reflecting these economies at the consumer level. On the other hand, with a differential out-of-store pricing policy, consumers would not only gain the saving available from low-cost outlets but would also be in a position to choose among alternative systems—involving different degrees of service and convenience—when the relative costs are transmitted through the purchase price. The economies of large-volume deliveries would, of course, be reflected directly in prices paid by retail home-delivery customers. Such price differentials could reflect the real cost differences involved in making large- versus small-volume stops and, in this way, provide consumers with a realistic basis for their choice of services associated with store and home-delivery purchases.

Under conditions of a perfect market, the free choice of consumers on the one hand and the free entry of producers and businessmen on the other would result in a system of prices that would accurately reflect costs—and thus result in an economically efficient allocation of resources. It must be recognized, however, that economic efficiency is not always synonymous with social welfare. For this reason, persons making up society as a whole may choose a different goal—for example, the protection of the small, independent businessman. This may, in itself, prevent the economically efficient use of resources in an absolute sense. If intelligent decisions of this latter type are to be made, the "costs" of such subsidies must be known so that they may be balanced against the gains. The results of the present report may be applied: (1) to provide a basis upon which administered prices *could* more closely approximate perfect market prices; and (2) to suggest the nature of the costs, to society, of continuing a system which subsidizes certain elements in milk distribution at the expense of others.

PLANT		DATE		ROUTE NO.					
Stop No.	Time Bet. Stops	Ticket No. and Type of Stop	Secure Order	Put up Order	Del.	Wait	Talk	Sec. Sign.	

APPENDIX A

I. Instructions to Timers, Wholesale Route Studies

The attached sample forms will be used in conducting all wholesale route studies. The first two lines of the form provide for certain nonrecurring data and are largely self-explanatory. Under type of route, the observer will indicate the preponderance of stops, for example, market, restaurant, and so forth. Insofar as the district is concerned, if some indication can be given of the outer street boundaries of the route, it will prove helpful. The wholesale route service will be divided into the following types for purposes of this study: market, restaurant, school, fountain, hotel, boarding house, bakery, hospital, commissary, and bars. It is to be noted that the time study form has a space for indicating the de-

livery ticket number and the type of stop.

The servicing of the stop involves the following elements which will be timed.

1. *Secure order.* Securing the order includes all of the time which is required to obtain an order, including the writing up of the sales tag, but not including the extension of the sales tag. It will include walking to the customer's premises to obtain the order, checking customer's ice-box to determine what is needed, and returning to the truck. There are exceptions to the general procedure which must be noted. In certain instances the driver will immediately take into the store one or more cases of product knowing that there will be at least this requirement each day. After dropping these cases, he then secures the order. The time to be allocated to securing the order and

Sec. Cash	Comp. Del.	Arr. Load	Arr. Ice Box	Ser. Ice Box	No. of Steps	No. of Dist.	Pkgs.	Labor Units	Misc. Function and Info.

the time which will be allocated to taking deliveries must depend upon the observation of the timer. For instance, if all of the products required for this particular stop could be made in one trip, but after checking with the customer another trip is required to complete the delivery, it is feasible that 50 per cent of the time of the first delivery trip will be allocated to securing the order and 50 per cent of the time to delivering the product. However, if more than one trip is required and by taking the known requirements before securing the order the driver is able to eliminate one of the trips, then proportionately more time would be allocated to delivering the product. To illustrate further, in an instance where the driver should take six or eight cases which would take considerable time to load onto his dolly for delivery, this then would not be charged on a 50-50 basis, but a lesser proportion would be charged

to securing the order. There is also the circumstance on certain routes where some orders are made up in advance by the driver. This information can be picked up beforehand and then allocated between the stops involved.

2. *Put-up order.* Include the time required to secure product from truck to make up customer's order.

3. *Delivery.* Include all of the time that is required to take the product from the truck to the customer's premises and place at designated point of delivery. If the routeman has to wait for the customer to check the load, the waiting time should be listed under the column, "wait." If he stops work completely to talk to the customer, list this under column, "talk."

4. *Wait.* Include waiting for the order, waiting for cash or signature, and waiting for customer to check the load.

5. *Talk.* The element "talk" includes all talking which interrupts the normal func-

tions the driver performs in making the delivery. It does not include any conversation which may be had while the driver is performing his ordinary functions. Any talking done while the man is waiting should be charged to "waiting" and not "talking."

6. *Secure signature.* Include time required for driver to extend the sales tag and for customer to check the tag and sign it.

7. *Secure cash.* Include time required for driver to extend the sales tag and for customer to check the tag and count out the cash. This will also include the time it takes the driver to check the cash.

8. *Complete delivery.* Include time required to pick up empty bottles or cases, return them to the sidewalk, and place them on the truck. Also include time required for the driver to get back into the truck and be ready to start the engine to drive to the next stop.

9. *Arrange load.* Include time of driver spent in rearranging cases on the truck, which time is not directly chargeable to putting up orders.

In order to establish the different types of service which may be made available to a customer, provision has been made on the study sheet for (1) "icebox arranged" and (2) "icebox serviced." Icebox arranged indicates that the icebox was checked and the product on hand arranged by the driver before the order was taken. Icebox serviced indicates that the order for the day was placed and arranged in the icebox after the order was taken. If either or both of these services are performed by the routeman, an X will be placed in the proper column. In the event that such a service is not performed, the timer will place a dash in the column.

Provision has also been made for indicating the number of steps the driver takes from the truck to the point of delivery. This refers only to the steps taken on one trip during the actual delivery.

Under the column, "No. of Dist.," will be shown the number of distributors who are delivering milk to the particular stop. Include in this number the distributor under study.

RETAIL TIME

COMPANY		ROUTE NO.		NAME OF DRIVER		
NO. UNITS ON LOAD		COMMENTS ON DISTRICT SERVED				
Operation	Driving Time	No. Customers Served	No. Units Served	No. Products	Distance of Serve	No. of Stairs

Under Miscellaneous Functions and Information will be listed such information as time out for coffee, time out for lunch, and any other time expended which is not directly chargeable to the functions above mentioned.

A separate sheet has been provided which breaks down the delivery to packages. Each delivery will be listed on this separate sheet and correlated by number with the delivery time on the first sheet. At the end of the day, the following information should be added in the space, Miscellaneous Functions and Information.

1. *Characteristics of Driver.* State whether he was sick, fast, normal, lazy, incompetent, or any other characteristics.

2. *Characteristics of Route.* Whether it is heavy traffic, hilly, level, scattered stops, and so forth.

**II. Instructions to Timers,
Retail Route Studies**

The purpose of this study of retail milk delivery routes is to obtain accurate and reliable information on time require-

ments for deliveries of various sizes. This information is needed in order to develop a system of pricing which will reflect the economies of large-volume deliveries. To do this it is imperative that you get the confidence and coöperation of the driver with whom you are working.

It may be well to indicate to the routeman beforehand that you are not attempting to see how "good" he is compared with other routemen and that you do not want him to attempt to set a speed record. On the other hand, point out that he has nothing to gain by prolonging the time spent on his route for that day. The things we are looking for are *average* and *typical* rates of performance.

It may increase the driver's confidence in you and in the job you are doing if you tell him that the data you collect will be kept confidential and available only to the members of the Bureau of Milk Control and Giannini Foundation whose job it is to analyze and summarize the individual records into final form. No milk company official will have access to records indicating the performance of

STUDY SHEET

Sheet.....of.....Sheets

TIME LEAVE PLANT		MILEAGE LEAVE PLANT		TIME 1st STOP		MILEAGE 1st STOP		TIMER		
TIME LAST STOP			MILEAGE LAST STOP			TIME RETURN PLANT			MILEAGE RETURN PLANT	
TIME FOR DELIVERY OPERATION					Time to Arrange Load	Misc. and Personal Time	Comments			
Gross Delivery	Collect	Wait and Talk	Other Delivery	Net Delivery						

any individual. Try to impress him that you want to observe how he *normally* does his work. Furthermore, if he usually has a beer on the sly, have one with him.

The attached sample forms will be used in conducting all retail route studies. The first two lines of the form provide for certain nonrecurring data and are largely self-explanatory. Under "comments on district served" indicate the predominant characteristics of the area covered—whether the terrain is level or hilly, if it is urban or rural, with primarily single dwellings or apartment houses, et cetera.

Note that only four types of operations are to be timed. These are: (1) driving, (2) direct delivery, (3) arrange load, and (4) miscellaneous and personal time. The definition of these operations is as follows:

1. *Driving*—from the time the route-man takes his place behind the wheel and begins the operation of putting the vehicle into motion until the vehicle has been securely parked and he has left the driving position.
2. *Direct delivery*—from the time the man begins to reach for the product to be delivered until he has returned to the truck and has completed all of the normal *routine* functions involved in each delivery, including returning the empty bottles and noting an entry in his book. This will be the "gross delivery time."

For those cases where the driver collects on the day you are observing, determine how much time is taken for the actual collecting operation and enter this under "collect."

In the same manner, note the time that is spent on each delivery in waiting or in "passing the time of day" for or with the customer. Enter this under "wait and talk." Any other interruptions should be noted in the "other delivery" column and explained under "comments."

The entry "net delivery" which will be used as a measure of delivery time exclusive of such added elements as collecting and wait and talk can be computed from the "gross delivery" less the time spent on these nonrecurring elements. This calculation can be made in the office and so it is not necessary that you make an entry in the "net delivery" column while on the route.

In some cases, it will be necessary for the driver to return to the truck for extra products. When this occurs, enter the special trip under "operation" as a separate item across the board and label it "extra trip."

Space is provided for you to indicate the volume of delivery per trip. Please enter the number of units, by container sizes, that are delivered.

Also, a notation is requested of the number of different *products* which are delivered. For the purpose of this study, items which must be obtained from different cases will constitute a different product. For example, if the delivery is three quarts of regular homogenized milk, the appropriate entries will be three units, one product. If one quart of homogenized, one quart of cream top, and one quart of buttermilk are delivered to a single customer, the entry would be three units, three products. Furthermore, different container sizes of the same item will be treated as different products and so identified.

Whenever a single delivery trip is made to serve more than one customer—for example, two or more customers in the same apartment house—please note the number of customers served in the column so indicated. Then further entries should be made as before.

Note that it will be necessary for you to accompany the driver on all of the delivery trips in order to obtain all of this information and, furthermore, so that a measurement of the distance involved may be obtained.

It is suggested that you count the number of steps that *you* take on the one-way trip from the truck to the point of delivery. Be sure to measure your normal stride and make a note of it on each route study you make. If you decide to use any other type of measurement, be sure to indicate just what measure you have used. The importance of this measurement cannot be overemphasized.

Logically, the distance that the driver must walk in making a de-

livery is a very important factor in determining the time requirement for delivery. Since we are not contemplating at the moment at least to price milk on the basis of delivery distance, this information is needed so that the influence of variations in distance can be eliminated in our analysis.

3. *Arrange load*—enter here any time taken in rearranging cases on the truck, which time is not directly chargeable to direct time per customer serve.
4. *Miscellaneous and personal time*—include here—with a notation of what is being done—all time which is not entered in the other items above described.

APPENDIX B

Table B-1. Wholesale Modifiers for Various Packages Handled by Distributors (Note: When 1 quart of milk, wholesale, in fiber, equals 1 unit)

Product	Fiber		Glass	
	Units per case	Labor units	Units per case	Labor units
Milk:*				
10-gallon can	..	18.00	..	....
5-gallon can	..	9.00	..	....
3-gallon can	..	8.00	..	....
2-gallon can	..	7.00	..	....
1-gallon can	..	6.00	..	....
½ gallon	12	2.00	8	2.20
1 quart	12	1.00	12	1.50
1 quart	20	1.00	..	....
1 quart	24	1.00	..	....
1 pint	20	0.80	20	1.30
1 pint	40	0.80	24	1.30
½ pint	40	0.60	20	1.00
½ pint	80	0.60	24	1.00
Cream:				
3-gallon can	..	8.00	..	....
2-gallon can	..	7.00	..	....
1-gallon can	..	6.00	..	....
1 quart	12	2.00	12	3.00
1 quart	20	2.00	..	....
1 quart	24	2.00	..	....
1 pint	20	1.50	20	2.50
1 pint	40	1.50	24	2.50
½ pint	40	1.00	20	1.50
½ pint	80	1.00	24	1.50
Half-and-half:†				
3-gallon can	..	8.00	..	....
2-gallon can	..	7.00	..	....
1-gallon can	..	6.00	..	....
1 quart	12	1.20	12	1.80
1 quart	20	1.20	..	....
1 quart	24	1.20	..	....
1 pint	20	1.00	20	1.50
1 pint	40	1.00	24	1.50
½ pint	40	0.80	20	1.20
½ pint	80	0.80	24	1.20
Butter:				
1 pound	..	1.00	..	....

* Includes homogenized and Golden V.

† Includes skim, chocolate, buttermilk, and orange.

Table B-1—Continued

Product	Fiber		Glass	
	Units per case	Labor units	Units per case	Labor units
Eggs:				
1 dozen	..	1.00	..	....
Cottage cheese:				
1 pound and under	..	1.00	..	....
Over 1 pound	..	2.00	..	....
Evaporated milk:				
1 case	..	18.00	..	....

Table B-2. Labor Unit Modifiers—Retail

Product	Number of labor units		
	1.0	1.2	1.8
Milk	Quarts Pints Third quarts Half pints	None	Half gallons
Cream	Half pints	Quarts Pints	
Half-and-half*	Pints Half pints	Quarts	
Other		Butter—pound Eggs—dozen Cottage cheese—1 pound and under	

* Includes skim, chocolate, buttermilk, and orange.

APPENDIX C

Section 4280, Article 6, Chapter 17, Division 6,
Agricultural Code of the State of California
(Relating to Mandatory Provisions of Stabilization
and Marketing Plans for Fluid Milk in Defining
"Unfair Trade Practices")

4280. Each stabilization and marketing plan shall contain provisions for prohibiting distributors and retail stores from engaging in the unfair practices hereinafter set forth:

(a) The payment, allowance or acceptance of secret rebates, secret refunds, or unearned discounts by any person, whether in the form of money or otherwise.

(b) The giving of any milk, cream, dairy products, services or articles of any kind, except to bona fide charities, for the purpose of securing or retaining the fluid milk or fluid cream business of any customer.

(c) The extension to certain customers of special prices or services not made available to all customers who purchase fluid milk or fluid cream of like quantity under like terms and conditions.

(d) The false or misleading advertising of fluid milk or fluid cream as defined in Sections 17500, 17501, and 17502 of the Business and Professions Code.

(e) The purchase of any fluid milk in excess of 200 gallons monthly from any producer or association of producers unless a written contract has been entered into with such producer or association of producers stating the amount of fluid milk to be purchased for any period. The quantity of such milk to be paid for as Class 1 in pounds of milk or pounds of milk fat or gallons of milk, and the price to be paid for all milk received, but in any marketing area where an equalization pool is a part of a stabilization and marketing plan, such contract need not specify the quantity of milk in any one class. The contract shall also state the date and method of payment for such fluid milk, which shall be that payment shall be made for approximately one-half of the milk delivered in any calendar month not later than the first day of the next following month and the remainder not later than the fifteenth day of said month, the charges for transportation if hauled by the distributor, and may contain such other provisions as are not in conflict with this chapter, and shall contain a proviso to the effect that the producer shall not be obligated to deliver in any calendar month fluid milk to be paid for at the minimum price for fluid milk that is used for Class 3, as said class is defined in Section 4228. A signed copy of such contract shall be filed by the distributor with the director within five days from the date of its execution. The provisions of this subdivision relating to dates of payment shall not apply to contracts for the purchase of fluid milk from nonprofit cooperative associations of producers.

(f) The purchasing, processing, bottling, transporting, delivering or otherwise handling in any marketing area of any fluid milk or fluid cream which is to be or is sold or otherwise disposed of by such distributor at any place in the geographical area within the outer, outside and external boundaries or limits of such marketing area, whether such place is a part of the marketing area or not, at less than the minimum wholesale and minimum retail prices effective in such marketing area.

(g) The payment of a lesser price by a distributor to any producer for fluid milk or fluid cream which is distributed to any person, including agencies of the federal, state or local government, located upon property within the geographical limits of any marketing area for less than the minimum prices established by the director to be paid by distributors to producers for fluid milk or fluid cream for said marketing area.

LITERATURE CITED

1. BLACK, J. D., and NEIL T. HOUSTON
Research in resource-use efficiency in the marketing of farm products. Cambridge: Harvard Studies in Marketing Farm Products No. 1-H. 1950.
2. BRESSLER, R. G., JR.
Efficiency of milk marketing in Connecticut. 10. Consumer demands and preferences in milk delivery. Connecticut Agr. Exp. Sta. Bul. 257. 1948.
3. BRESSLER, R.G., JR.
Agricultural marketing research. Jour. Farm Econ. XXXI (1). February, 1949.
4. BROWNLEE, O. H.
Marketing research and welfare economics. Jour. Farm Econ. XXX (1). February, 1948. Pp. 55-68.
5. CLARKE, D. A., JR.
Fluid milk price control in California. A Special Report of the Joint Legislative Committee on Agriculture and Livestock Problems. Sacramento: State Printing Office. 1955. Pp. 35-39.
6. THE ELWELL PLAN OF PRICING MILK (editorial)
Amer. Milk Rev. XII (11). November, 1950.
7. HILLMAN, J. S., J. D. ROWELL, and V. L. ISRAELSEN
Barriers to the interstate movement of milk and dairy products in the eleven western states. Arizona Agr. Exp. Sta. Bul. 255. 1954.
8. NATIONAL GRANGE
Barriers to increased consumption in fluid milk. Wash., D.C.: January, 1955.
9. SHEPHERD, G. S.
Marketing farm products—economic analysis (3d ed.). Iowa State College Press, 1955. Pp. 18-25.
10. SPENCER, LELAND
An economic survey of the Los Angeles milk market. California Agr. Exp. Sta. Bul. 513. (Giannini Foundation of Agricultural Economics Paper 19). 1931.
11. TAYLOR, GEORGE R., EDGAR L. BURTIS, and FREDERICK A. WAUGH
Barriers to internal trade in farm products. Wash., D.C.: United States Department of Agriculture. March, 1939.
12. TINLEY, J. M.
Public regulation of milk marketing in California. Berkeley: University of California Press. 1938. Chapters I through IV.
13. UNITED STATES DEPARTMENT OF AGRICULTURE
Marketing margins and efficiency, a report of the marketing research workshop (held at Purdue University, July 9 to 19, 1950). Wash., D.C. (See especially the reports of Work Groups I-V.)
14. UNITED STATES DEPARTMENT OF AGRICULTURE
Regulations affecting the movement and merchandising of milk; a study of the impact of sanitary requirements, federal orders, state milk control laws, and truck laws on price, supply, and consumption. United States Marketing Research Report 98. Wash., D.C., 1955.

ACKNOWLEDGMENTS

The writer is indebted to a number of persons who coöperated in this study. Most of the data were collected by personnel of the California Bureau of Milk Control, and thanks are due W. B. Woodburn and B. J. Campbell, former Chiefs of the Bureau, and D. A. Weinland, the present Chief, for making that personnel available. In addition, Arden Farms, Adohr Milk Farms, Foremost-Golden State, Carnation Company, and Borden's turned over trained men to the Giannini Foundation for use in conducting the study. Virtually all companies operating in the seven markets covered supplied statistical assistance in making data available.

~~YOUR~~ Consider ~~the~~ Future in Agricultural Economics

Agricultural economics applies SCIENCE to the BUSINESS OF FARMING . . . to the marketing of farm products, to the use of agricultural and range resources.

If agriculture is to continue as an important segment of our national economy, farmers must be adequately trained in the business of farming. The University of California's course of study in agricultural economics is a step toward that goal.

The curriculum . . . presented on the Davis campus, places major emphasis on Farm Management . . . but also provides instruction in Marketing, Co-operative Marketing, Agricultural Finance, Policy, and related subjects. Supplementary work may also be taken in such branches of agriculture as Agronomy, Animal Husbandry, Pomology, Agricultural Engineering, and the like.

The faculty . . . is comprised of trained, experienced economists, many with national and international reputations in their fields. The staff is active in service and research work in all of the Western States.

Job opportunities . . . can best be understood by pointing to positions now occupied by graduates. The largest percentage are farmers. Other lines of endeavor include:

Farm Managers • Credit work • Farmer Organizations
Marketing Organizations • Agricultural Extension work
State and Federal Departments of Agriculture work
College teaching and research • High school teaching

For more information: Write to the Department of
Agricultural Economics,
University of California, Davis.

or: See your University of California
Farm Advisor for college entrance
requirements.